NAIC NATIONAL ASSOCIATION OF INSURANCE COMMISSIONERS

Draft date: 10/25/23

Virtual Meeting

JOINT MEETING OF THE PROPERTY AND CASUALTY RISK-BASED CAPITAL (E) WORKING GROUP AND THE CATASTROPHE RISK (E) SUBGROUP
Thursday, November 16, 2023
12:00 – 1:00 p.m. ET / 11:00 a.m. – 12:00 p.m. CT / 10:00 – 11:00 a.m. MT / 9:00 – 10:00 a.m. PT

ROLL CALL

PROPERTY AND CASUALTY RISK-BASED CAPITAL (E) WORKING GROUP

Tom Botsko, Chair	Ohio	Anna Krylova	New Mexico
Wanchin Chou, Vice Chair	Connecticut	Ni Qin	New York
Charles Hale	Alabama	Will Davis	South Carolina
Rolf Kaumann	Colorado	Miriam Fisk	Texas
Virginia Christy	Florida	Adrian Jaramillo	Wisconsin
Sandra Darby	Maine		

NAIC Support Staff: Eva Yeung

CATASTROPHE RISK (E) SUBGROUP

Wanchin Chou, Chair	Connecticut	Alexander Vajda	New York
Jane Nelson, Vice Chair	Florida	Tom Botsko	Ohio
Rolf Kaumann	Colorado	Andrew Schallhorn	Oklahoma
Travis Grassel	Iowa	Will Davis	South Carolina
Sandra Darby	Maine	Miriam Fisk	Texas
Anna Krylova	New Mexico		

NAIC Support Staff: Eva Yeung

AGENDA

1. Consider Exposure of Proposal 2023-16-CR (2023 Cat Event List) — Attachment 1
   —*Tom Botsko (OH)*

2. Hear a Presentation from the American Academy of Actuaries (Academy) on the Report "Update to Property and Casualty Risk-Based Capital Underwriting Factors and Investment Income Adjustment Factors" — Attachment 2
   —*Ron Wilkins (Academy)*

3. Discuss Any Other Matters Brought Before the Task Force
   —*Tom Botsko (OH)*

4. Adjournment

Capital Adequacy (E) Task Force

RBC Proposal Form

[ ] Capital Adequacy (E) Task Force	[ ] Health RBC (E) Working Group	[ ] Life RBC (E) Working Group
[x] Catastrophe Risk (E) Subgroup	[ ] Investment RBC (E) Working Group	[ ] Op Risk RBC (E) Subgroup
[ ] C3 Phase II/ AG43 (E/A) Subgroup	[ ] P/C RBC (E) Working Group	[ ] Stress Testing (E) Subgroup

DATE: 11/1/2022	**FOR NAIC USE ONLY**
CONTACT PERSON: Eva Yeung	Agenda Item # 2023-16-CR
TELEPHONE: 816-783-8407	Year 2023
EMAIL ADDRESS: eyeung@naic.org	**DISPOSITION**
ON BEHALF OF: Catastrophe Risk (E) Subgroup	[ ] ADOPTED 1st release:
NAME: Wanchin Chou	2nd release:
TITLE: Chair	[ ] REJECTED
AFFILIATION: Connecticut Department of Insurance	[ ] DEFERRED TO
ADDRESS: 153 Market St,	[ ] REFERRED TO OTHER NAIC GROUP
Hartford, CT 06103	[x] EXPOSED 1st release:11/16/23
	2nd release:
	[ ] OTHER (SPECIFY)

IDENTIFICATION OF SOURCE AND FORM(S)/INSTRUCTIONS TO BE CHANGED

[ ] Health RBC Blanks	[ ] Property/Casualty RBC Blanks	[ ] Life RBC Instructions
[ ] Fraternal RBC Blanks	[ ] Health RBC Instructions	[ ] Property/Casualty RBC Instructions
[ ] Life RBC Blanks	[ ] Fraternal RBC Instructions	[x] OTHER Cat Event Lists

DESCRIPTION OF CHANGE(S)

2023 U.S. and non-U.S. Catastrophe Event Lists

REASON OR JUSTIFICATION FOR CHANGE **

New events were determined based on the sources from Swiss Re and Aon Benfield.

Additional Staff Comments:

11/16/23 – The Subgroup and the PCRBC WG exposed this proposal for a 7-public comment period ending 11/23/22.

**** This section must be completed on all forms.** **Revised 11-2013**

Type of Event	Name	Date	Location	Overall losses when occurred
Wildfire	Texas	2014	Texas, California	> 25 million
Earthquake		2014	California	25+ million
Hurricane	Patricia	2015		25+ million
Hurricane	Joaquin	2015		25+ million
Wildfire	Butte Fire	9/9/15-10/1/15	Amador County, California	~ 300 million
Wildfire	Valley Fire	9/12/15-10/15/15	Lake, Napa and Sonoma County, California	~ 700 million
Hurricane	Matthew	2016	Florida, North Carolina, South Carolina, Georgia and Virginia	$ 2,698,400,000
Hurricane	Hermine	2016	Florida, North Carolina, South Carolina, Georgia and Virginia	$ 245,640,000
Wildfire	Erskine Fire	6/23/16-7/11/16	Lake Isabella, Kern County, California	~26 million
Wildfire	Soberanes Fire	7/22/16-9/30/16	Soberanes Creek, Garrapata State Park, Santa Lucia Preserve, Monterey County, California	> 200 million
Wildfire	Chimney Fire	8/13/16-9/6/16	Santa Lucia Range, San Luis Obispo County, California	> 25 million
Wildfire	Clayton Fire	8/13/16-8/26/16	Lake County, California	>25 million
Wildfire	Gatlinburg Wildfire	11/29/16-12/5/16	Sevier County, Gatlinburg, Pigeon Forge, Tennessee	~637 million
Wildfire	Northern California Wildfires	10/8/17-10/31/17	Northern California	~ 11 billion
Wildfire	Southern California Wildfires	12/4/17-12/23/17	Southern California	~ 2.2 billion
Hurricane	Harvey	2017	Texas, Lousiana	25+ million
Hurricane	Jose	2017	East Coast of the United States	25+ million
Hurricane	Irma	2017	Eastern United States	25+ million
Hurricane	Maria	2017	Southeastern United States, Mid-Atlantic States	25+ million
Hurricane	Nate	2017	Louisiana, Mississippi, Alabama, Tennessee and Eastern United States	25+ million
Tropical Storm	Alberto	2018	Southeast, Midwest	25+ million
Hurricane	Lane	2018	Hawaii	25+ million
Tropical Storm	Gordon	2018	Southeast, Gulf coast of the United States, Arkansas and Missouri	25+ million
Hurricane	Florence	2018	Southeast, Mid-Atlantic	25+ million
Hurricane	Michael	2018	Southeastern and East Coasts of United States	25+ million
Wildfire	Spring Creek Fire	6/27/18-7/11/18	Spring Creek, Colorado	< 100 million
Wildfire	Carr, Mendocino California Wildfires	7/23/18-8/15/18	Northern California	>1,000 million
Wildfire	Northern California Camp Wildfire	11/8/18-11/25/18	Butte County, California	>7.5 billion
Wildfire	Southern California Woolsey Wildfires	11/8/18-11/21/18	Los Angeles andVentura County, California	2.9 billion
Hurricane	Dorian	2019	Southeast, Mid-Atlantic	500+ million
Hurricane	Barry	2019	Southeast, Midwest, Northeast	300+ million
Tropical Storm	Imelda	2019	Plains, Southeast	25+ million
Tropical Storm	Nestor	2019	Southeast	25+ million
Hurricane	Lorenzo	2019	Louisiana, Mississippi, Texas and Arkansas	25+ million
Wildfire	Saddleridge Wildfire	10/10/19-10/23/19	Sylmar, Los Angeles, Calimesa, Riverside County, California	<1,000 million
Wildfire	Kincade Wildfire	10/23/19-11/6/19	Northeast of Geyserville, Sonoma County, California	<1,000 million
Tropical Storm	Cristobal	2020	Southeast, Plains, Midwest	150 million
Tropical Storm	Fay	2020	Southeast, Northeast	400 million
Hurricane	Hanna	2020	Texas	350 million
Hurricane	Isaias	2020	Southeast, Mid-Atlantic, Northeast	> 3 billion
Hurricane	Laura	2020	Plains, Southeast, Mid-Atlantic	> 4 billion
Hurricane	Sally	2020	Southeast (Alabama, Mississippi, Louisiana)	> 1 billion
Tropical Storm	Beta	2020	Plains, Southeast	25+ million
Hurricane	Delta	2020	Gulf Coast of United States, Southeast, Northeast (AL, GA, NC, SC, MS, LA, TX)	> 2 billion
Hurricane	Zeta	2020	Gulf coast of the United States, Southeastern United States, Mid-Atlantic	> 1.5 billion
Wildfire	Cameron Peak	08/13/20-12/02/20	Roosevelt National Forest, Larimer County, Colorado	~71 million
Wildfire	SCU Lighting Complex Wildfire	8/16/20-9/16/20	San Franciscon Bay Area, Central Valleym Santa Clara, Alameda, Contra Costa, San Joaquin, Merced, Stanislaus	<1,000 million
Wildfire	Beachie Creek Wildfire	8/16/20-10/10/20	Approx. 2 miles south of Jaw Bones flats in rugged terrain deep in the Opal Creek Wilderness.	>1,000 million
Wilfire	CZU Lightning Complex Wildfire	8/16/20-9/22/20	San Mateo and Santa Cruz Counties, California	>1,000 million
Wildfire	LNU Lightning Complex WildFire	8/17/20-10/2/20	Lake, Napa, Sonoma, Solano, and Yolo Counties, California	> 1,000 million

Wildfire	Carmel Fire	8/18/20-9/4/20	Carmel Valley, California	<1,000 milion
Wildfire	North Complex Fire	8/18/20-10/12/20	Plumas and Butte Counties, California	<1,000 milion
Wildfire	Creek Fire	9/4/20-10/12/20	Fresno and Madera Counties, California	<1,000 milion
Wildfire	Bobcat Fire	9/6/20-10/23/20	Central San Gabriel Mountains, in and around the Angeles National Forest California	< 1,000 million
Wildfire	Babb Road Fire	9/7/20-9/18/20	Malden and Pine City, Palouse County of Eastern Washington	<1,000 million
Wildfire	Almeda Fire	9/7/20-9/16/20	Jackson County, Oregon	<1,000 milion
Wildfire	Holiday Farm Fire	9/7/20-10/3/20	Willamette National Forest	<1,000 milion
Wildfire	Echo Mountain Complex Fire	9/7/20-9/23/20	north of Lincoln City, Oregon	<100 milion
Wildfire	Riverside FIre	9/8/20-10/3/20	Valley Drive between Misty Ridge Drive and Mitchell Avenue, Oregon	<100 milion
Wildfire	Slater Fire	9/8/20-10-9/20	Northern California and Southern Oregon	<100 million
Wildfire	Glass Fire	9/27/20-10/19/20	Napa and Sonoma Counties, California	> 1,000 million
Wildfire	East Troublesome Fire	10/14/20-11/9/20	Grand County, Colorado	~543 million
Tropical Storm	Claudette	2021	Gulf Coast of the United States, Georgia, Carolinas	> 350 million
Hurricane	Elsa	2021	East Coast of the United States	1.2 billion
Tropical Storm	Fred	2021	Eastern United States (particularly Florida and North Carolina)	1.3 billion
Hurricane	Henri	2021	Northeastern United States	550 million
Hurricane	Ida	2021	Gulf Coast of the United States (especially Louisana), East Coast of the United States (especially the Northeastern United States)	44 billion
Tropical Storm	Nicholas	2021	LA, TX	>1.1b
Tropical Storm	Wanda	2021	Southern United States, Mid-Atlantic United States, Northeastern United States	>200 million
Wildfire	Bootleg Wildfire	7/17/21-8/6/21	Northwest of Beatty, Oregon	<1,000 million
Wildfire	Dixie Wildfire	7/14/21-10/5/21	Butte, Plumas, Tehama, Lassen and Shasta Counties, California	>1,000 million
Wildfire	Caldor Fire	8/14/21-10/5/21	El Dorado National Forest and other areas of the Sierra Nevada in El Dorado, Amador, and Alpine County, Calfornia	<1,000 million
Wildfire	Corkscrew Fire	8/15/21-8/30/21	Ford, WA; Tum Tum, Springdale, City of Deer Park, Loon Lake, Clayton, H395, Scoop Mt	<100 million
Wilfire	Marshall Fire	12/30/21-1/1/22	Boulder County, Colorado	~ 2 billion
Wildfire	Calf Canyon/Hermits Peak Fire	4/6/22-8/22/22	San Miguel County, Mora County, Taos County	> 25 million
Wildfire	McKinney Fire	7/29/22-9/7/222	Siskiyou County, Northern California	> 25 million
Wildfire	Cedar Creek Fire	8/1/22-present	Central Oregon	> 25 million
Wildfire	Mosquito Fire	9/6/22- present	Northern California, Placer County, El Dorado County	> 25 million
Hurricane	Hurricane Fiona	9/18/22-9/20/22	PR	>3 billion
Hurricane	Ian	9/23/22-10/2/22	Florida and the Carolinas, FL, GA, NC, SC, VA	>110 billion
Hurricane	Hurricane Nicole	11/9/22-11/11/22	FL, GA, SC	>1 billion
Wildfire	Hawaii Wildfire	8/8/23-8/17/23	Hawaii	> 25 million
Hrricane	Hurricane Hilary	8/17/23-8/22/23	West, Southwest United States	> 25 million
Wildfire	Washington Wildfire	8/18/23-8/22/23	Washington	> 25 million
Hurricane	Hurricane Idalia	8/27/23-8/31/23	Southeastern United States	> 25 million
Hurricane	Hurricane Lee	9/14/23-9/17/24	Northeast United States	> 25 million
Tropical Storm	Ophelia	9/22/23-9/26/23	East Coast of the United States	> 25 million

Attachment 1

Year	Event Type	Begin	End	Event	Country	Affected Area (Detail)	Munich Re NatCATService Insured losses (in original values, US$m) Criteria: insured losses equal/greater US$ 25m. Tries to reflect non-US losses only	Swiss Re Sigma: Insured Loss Est. US$m (mid point shown if range given) Mostly reflect total US and nonUS losses combined.	
2014	Earthquake	07/07/2014		Earthquake	Mexico, Guatemala		N/A	N/A	25+milion
2014	Earthquake	04/01/14		Earthquake	Chile		N/A	N/A	100+milion
2014	Earthquake	12/02/2014		Earthquake	China		N/A	N/A	350+milion
2014	Earthquake	05/04/2014		Earthquake	China		N/A	N/A	80+milion
2014	Earthquake	05/05/2014		Earthquake	Thailand		N/A	N/A	62+milion
2014	Earthquake	05/24/14		Earthquake	China		N/A	N/A	60+milion
2014	Tropical Storm	06/14/14	06/16/14	TS Hagibis	China		N/A	N/A	131+milion
2014	Super Typhoon	07/08/14	07/11/14	STY Neoguri	Japan		N/A	N/A	100+milion
2014	Super Typhoon	07/15/14	07/20/14	STY Rammasun		Philippines, China, Vietnam	N/A	N/A	570+milion
2014	Typhoon	07/22/14	07/24/14	TY Matmo		Taiwan, China, Philippines	N/A	N/A	570+milion
2014	Cyclone	01/10/14	01/12/14	CY Ian	Tonga		N/A	N/A	48+milion
2014	Cyclone	04/10/14	04/14/14	CY Ita	Australia		N/A	N/A	1+billion
2014	Wildfire	Summer 2014		Northwest Territories Fire	Canada	Northwest Territories, Canada			~$3.6b
2015	Hurricane	08/16/92	08/28/92	Hurrican Andrew	Bahamas	Bahamas			> 25 million
2015	Hurricane	10/20/15	10/24/15	Hurricane Patricia		Central America, Mexico	N/A	N/A	> 25 million
2015	Typhoon	06/26/15	07/13/15	Typhoon Chan-hom (Falcon)		Guam, Northern Mariana Islands, Philippines, Japan, Taiwan, Chian, Korea, Russian Far East	N/A	N/A	> 25 million
2015	Severe Tropical Storm	07/01/15	07/10/15	Severe Tropical Storm Linfa (Egay)		Philippines, Taiwan, China	N/A	N/A	> 25 million
2015	Typhoon	07/02/15	07/18/15	Typhoon Nangka		Marshall Islands, Mariana Islands and Japan	N/A	N/A	> 25 million
2015	Typhoon	07/29/15	08/12/15	Typhoon Soudelor (Hanna)		Mariana Islands, Japan, Philippines, Taiwan, Eastern China and South Korea	N/A	N/A	> 25 million
2015	Typhoon	08/13/15	08/30/15	Typhoon Goni (Ineng)		Mariana Islands, Japan, Philippines, Taiwan, China, Russia and Korea	N/A	N/A	> 25 million
2015	Severe Tropical Storm	09/06/15	09/11/15	Severe Tropical Storm Etau		Japan, Russian Far East	N/A	N/A	> 25 million
2015	Typhoon	09/19/15	09/30/15	Typhoon Dujuan (Jenny)		Ryukyu Islands, Taiwan, East China	N/A	N/A	> 25 million
2015	Typhoon	09/30/15	10/05/15	Typhoon Mujigae (Kabayan)		Philippines, Vietnam and China	N/A	N/A	> 25 million
2015	Typhoon	10/12/15	10/21/15	Typhoon Koppu (Lando)		Northern Mariana Islands, Philippines, Taiwan, Ryukyu Islands	N/A	N/A	> 25 million
2015	Typhoon	12/03/15	12/08/15	Storm Desmond		Ireland, Isle of Man, United Kingdom, Iceland, Norway and Sweden	N/A	N/A	> 25 million
2015	Hurricane	09/28/15	10/15/15	Hurricane Joaquin		Caribbean Islands, Portugal	N/A	N/A	> 25 million
2015	Earthquake	04/27/15		Earthquake	Nepal		N/A	N/A	> 25 million
2015	Earthquake	09/22/15		Earthquake	Chile		N/A	N/A	> 25 million
2015	Wildfire	11/25/15	12/02/15	Pinery Bushfire	Australia	Lower Mid North, Light River, West Barossa, South Australia, Australia			$75m
2015	Wildfire	12/25/15		Wye River, Separation Creek bushfires,	Australia	Great Ocean Road region of Victoria, Australia			~$110m
2016	Hurricane	08/28/16	09/06/16	Hurricane Hermine		Dominican Republic, Cuba, The Bahamas	N/A	N/A	> 25 million
2016	Tropical Cyclone	02/16/16	02/22/16	TC Winston		South Pacific Islands	N/A	N/A	> 25 million
2016	Earthquake	02/06/16		Earthquake	Taiwan	Asia	N/A	N/A	> 25 million
2016	Earthquake	01/03/16		Kaohsiung EQ	India, Bangladesh, Myanmar	Asia	N/A	N/A	> 25 million
2016	Earthquake	02/14/16		Christchurch EQ	New Zealand	Oceania	N/A	N/A	> 25 million
2016	Earthquake	04/14/16	04/16/16	Kumamoto EQs	Japan	Asia	N/A	N/A	> 25 million
2016	Earthquake	04/16/16		Ecuador EQ	Ecuador	South America	N/A	N/A	> 25 million

Attachment 1

2016	Tropical Cyclone	05/14/16	05/23/16	CY Roanu	Sri Lanka, india, Bangladesh, China	Asia	N/A	N/A	> 25 million
2016	Earthquake	08/24/16		Italy EQ	Italy	Europe	N/A	N/A	> 25 million
2016	Tropical Cyclone	09/14/16	09/16/16	STY Meranti	China, Taiwan, Philippines	Asia	N/A	N/A	> 25 million
2016	Tropical Cyclone	07/08/16	07/12/16	STY Nepartak	China, Taiwan	Asia	N/A	N/A	> 25 million
2016	Tropical Cyclone	09/26/16	09/29/16	TY Megi	Taiwan, China	Asia	N/A	N/A	> 25 million
2016	Earthquake	09/10/16		Kagera EQ	Tanzania, Uganda	Africa	N/A	N/A	> 25 million
2016	Tropical Cyclone	08/29/16	09/01/16	TY Lionrock	China, Japan, South Korea	Asia	N/A	N/A	> 25 million
2016	Tropical Cyclone	09/19/16	09/22/16	TY Malakas	Japan, China	Asia	N/A	N/A	> 25 million
2016	Tropical Cyclone	08/18/16	08/20/16	TS Dianmu	China, Vietnam	Asia	N/A	N/A	> 25 million
2016	Tropical Cyclone	07/31/16	08/03/16	TY Nidia	China, Phillippines Vietnam	Asia	N/A	N/A	> 25 million
2016	Tropical Cyclone	08/02/16	08/10/16	HU Earl	Belize, Mexico, Carribbean Islands	Caribbean Islands, Mexico and Central America	N/A	N/A	> 25 million
2016	Tropical Cyclone	08/22/16	08/23/16	TS Mindulle	Japan	Asia	N/A	N/A	> 25 million
2016	Tropical Cyclone	09/06/16	09/08/16	HU Newton	Mexico	North America (non-U.S.)	N/A	N/A	> 25 million
2016	Tropical Cyclone	10/04/16	10/07/16	STY Chaba	Japan, Korea	Asia	N/A	N/A	> 25 million
2016	Tropical Cyclone	10/16/16	10/22/16	STY Haima	Phillipines, China	Asia	N/A	N/A	> 25 million
2016	Tropical Cyclone	10/14/16	10/20/16	TY Sarika	Phillipines, China, Vietanm	Asia	N/A	N/A	> 25 million
2016	Earthquake	10/26/16		Central Italy EQ	Italy	Europe	N/A	N/A	> 25 million
2016	Earthquake	10/27/16		Central Italy EQ	Italy	Europe	N/A	N/A	> 25 million
2016	Earthquake	10/21/16		Tottori	Japan	Asia	N/A	N/A	> 25 million
2016	Hurricane	09/28/16	10/10/16	Hurricane Matthew		Carribbean Islands and Eastern Canada	N/A	N/A	> 25 million
2016	Hurricane	08/28/16	09/06/16	Hurricane Hermine		Dominican Republic, Cuba, The Bahamas	N/A	N/A	> 25 million
2016	Wildfire	01/06/16		Waroona-Yarloop Bushfire	Western Australia				~$71.25m
2016	Wildfire	05/01/16	05/26/16	Canada Wildfire	Canada	Fort McMurray			$3.52b
2016	Wildfire	11/22/16	11/27/16	November 2016 Israel Fires	Israel	Various regions in Israel, mainly in Haifa, Judaean Mountains and the Sharon Plain			>$25m
2017	Earthquake	01/18/17		Earthquake	Italy	Europe	N/A	N/A	> 25 million
2017	Earthquake	01/28/17		Earthquake	China	Asia	N/A	N/A	> 25 million
2017	Earthquake	02/10/17		Earthquake	Philippines	Asia	N/A	N/A	> 25 million
2017	Earthquake	03/27/17		Earthquake	China	Asia	N/A	N/A	> 25 million
2017	Cyclone	03/28/17	04/05/17	CY Debbie	Australia	Queensland, New South Wales, New Zealand	N/A	N/A	> 25 million
2017	Earthquake	05/11/17		Earthquake	China	Asia	N/A	N/A	> 25 million
2017	Typhoon	07/29/17	07/31/17	TY Nesat & TS Haitang	China, Taiwan, Philippines	Asia	N/A	N/A	> 25 million
2017	Typhoon	08/07/17	08/09/17	Typhoon Noru	Japan	Asia	N/A	N/A	> 25 million
2017	Earthquake	08/08/17		Earthquake	China	Asia	N/A	N/A	> 25 million
2017	Typhoon	08/23/17	08/24/17	TY Hato	China	Macau, Hong Kong	N/A	N/A	> 25 million
2017	Typhoon	08/25/17	08/28/17	TY Pakhar	China	Asia	N/A	N/A	> 25 million
2017	Hurricane	08/25/17	09/02/17	Hurricane Harvey		Caribbean Islands and Central America	N/A	N/A	> 25 million
2017	Hurricane	08/30/17	09/16/17	Hurricane Irma		Caribbean Islands and Cape Verde	N/A	N/A	> 25 million
2017	Hurricane	09/05/17	09/26/17	Hurricane Jose		Caribbean Islands and Eastern Canada	N/A	N/A	> 25 million
2017	Hurricane	09/16/17	10/03/17	Hurricane Maria		Caribbean Islands, UK, Francs and Spain	N/A	N/A	> 25 million
2017	Earthquake	09/07/17		Earthquake		Mexico, Guatemala	N/A	N/A	> 25 million
2017	Earthquake	09/19/17		Earthquake	Mexico	Mexico City	>200	N/A	> 25 million
2017	Hurricane	10/04/17		Hurricane Nate		Central America, Cayman Islands, Cuba Yucatan Peninsula	N/A	N/A	> 25 million
2017	Wildfire	06/06/17		Knysna Fires	South Africa	Knysna region of the Western Cape			~$146m
2017	Wildfire	07/01/17	08/01/17	British Columnbia Wildfires	Canada	British Columbia			>$78m
2017	Wildfire	10/15/17	10/16/17	Iberian Wildfires	Portugal	Northern Portugal and Northwestern Spain			~$210m
2018	Earthquake	02/06/18		Earthquake	Taiwan				> 25 million
2018	Earthquake	02/16/18		Earthquake	Mexico				> 25 million
2018	Cyclone	02/09/18	02/20/18	CY Gita	Tonga, Fiji, Samoa, New Zealand				> 25 million

2018	Earthquake	02/26/18		Earthquake	Papua New Guinea				> 25 million
2018	Earthquake	03/05/18		Earthquake	Papua New Guinea				> 25 million
2018	Cyclone	03/17/18		CY Marcus					> 25 million
2018	Tropical Storm	05/23/18	05/27/18	Tropical Storm Mekunu	Yamen, Oman , Saudi Arabia				> 25 million
2018	Tropical Storm	06/02/18	06/07/18	Tropical Storm Ewiniar	Vietnam, China, Taiwan, Philippines and Ryukyu Islands	Guangdong Province, Jiangxi, Fujian, Zhejiang Provinces, and Hainan Island.			> 25 million
2018	Earthquake	06/18/18		Earthquake	Japan				> 25 million
2018	Super Typhoon	07/10/18	07/12/18	STY Maria	China, Taiwan, Guam and Japan	Fujian province, Yantze River Basin, Japan's Ryukyu Islands			> 25 million
2018	Tropical Storm	07/17/18	07/24/18	TS Sonh-Tinh	Vietnam, China, Loas	Japan, Russian Far East			> 25 million
2018	Tropical Storm	07/22/18	07/25/15	TS Ampil	China	Jiangsu, Zhejiang, Shandong, and Hebei			> 25 million
2018	Typhoon	07/27/18	08/03/18	TY Jongdari	Japan, China				> 25 million
2018	Earthquake	08/05/15	08/09/18	Earthquake	Indonesia				> 25 million
2018	Tropical Storm	08/09/18	08/15/18	TS Yagi	Philippines, China	Zhejiang, Anhui, Jiangsu and Shandong Provinces.			> 25 million
2018	Tropical Storm	08/13/18	08/19/18	TS Bebinca	China	Hong Kong, Guangdong and Hainan			> 25 million
2018	Typhoon	08/16/18	08/18/18	TY Rumbia	China	Shanghai, Jiangsu, Zhehiang, Anhui, Shandong and Henan			> 25 million
2018	Typhoon	08/23/18	08/25/18	TY Soulik	Japan, South Korea, China and Russia	Haenam County, South Jeolla Province			> 25 million
2018	Typhoon	09/04/18	09/05/18	RY Jebi	Japan, Mariana Islands, Taiwan, Japan, Russian Far East and Artic				> 25 million
2018	Earthquake	09/06/18		Earthquake	Japan	Hokkaido			> 25 million
2018	Super Typhoon	09/15/18	0918/18	STY Mangkhut	N. Mariana Islands, Philippines, China and Hong Kong				> 25 million
2018	Hurricane	Leslie	09/23/18	Hurricane Leslie	Azores, Bermuda, Europe	Azores, Bermuda, Madeira, Iberian Peninsula, France			> 25 million
2018	Hurricane	10/07/18	10/16/18	Hurricane Michael	Central American, Yucatan Peninsula, Cayman Islands, Cuba, Atlantic, Canad				> 25 million
2018	Wildfire	May-18	Aug-18	Sweden Wildfires	Sweden	ranging from north of Arctic Circle to the sourthern County of Scania.			>$87m
2018	Wildfire	Jul-18		Greece Wildfires	Greece	Attica, Greece			~38.1m
2019	Cyclone	05/03/19	05/05/19	Cyclone Fani	India, Bangladesh				>500 million
2019	Earthquake	06/17/19		Earthquake	China				> 25 million
2019	Tropical Storm	08/01/19	08/08/19	Tropical Storm Wipha	China, Vietnam				> 25 million
2019	Typhoon	08/09/19	08/11/19	Typhoon Lekima	China				> 855 million
2019	Typhoon	08/15/19	08/16/19	Typhoon Krosa	Japan				>25 million
2019	Hurricane	08/31/19	09/07/19	Hurricane Dorian	Caribbean, Bahamas, Canada				>1 billion
2019	Typhoon	09/05/19	09/08/19	Typhoon Lingling	Japan, China, Korea				>5.78 billion
2019	Typhoon	09/08/19	09/09/19	Typhoon Faxai	Japan				> 7 billion
2019	Hurricane	09/19/19	09/22/19	Hurricane Humberto	Bermuda				>25+ million
2019	Hurricane	09/17/19	09/26/19	Hurricane Lorenzo	Portugal				>25+ million
2019	Earthquake	11/26/19		Earthquake	Albania				>25+ million
2019	Cyclone	11/08/19	11/11/19	Cyclone Matmo (Bulbul)	India, Bangladesh				>25+ million
2019	Typhoon	10/01/19	10/02/19	Typhoon Hagibis	Japan				> 7 billion
2019	Earthquake	12/18/19		Earthquake	Philippines				>25+ million
2019	Wildfire	Sep-19	Mar-20	Australian Bushfires	New South Wales, Queensland, Victoria, South Australia, Western Australia, Tasmania and Northern Territory				~910 million
2020	Earthquake	03/22/20		Earthquake	Croatia				>25+ million
2020	Cyclone	04/01/20	04/11/20	Cyclone Harold	Solomon Islands, Canuatu, Fiji, Tonga				> 25+ million
2020	Tropical Storm	05/31/20		Tropical Storm Amanda	El Salvador, Guatemala, Honduras				> 25+ million
2020	Tropical Storm	06/01/20	06/05/20	Tropical Storm Cristobal	Mexico, Guatemala, El Salvador				150 million
2020	Hurricane	07/25/20	07/27/20	Hurricane Hanna	Mexico				350 million
2020	Hurricane	07/28/20	08/01/20	Hurricane Isaias	Caribbean, Canada				> 3 billion
2020	Hurricane	08/22/20	08/25/20	Hurricane Laura	Caribbean				> 4 billion
2020	Typhoon	05/15/20	05/22/20	Typhoon Amphan	India, Bangladesh, Sri Lanka				15 billion
2020	Tropical Storm	06/03/20	06/04/20	Tropical Storm Nisarga	India				> 25+ million
2020	Typhoon	08/03/20	08/04/20	Typhoon Hagupit	China, Taiwan				> 100+ million

2020	Hurricane	10/05/20	10/12/20	Hurricane Delta	Jamaica, Nicaragua, Cayman Island, Yucatan Peninsula				> 2 billion
2020	Hurricane	10/24/20	10/30/20	Hurricane Zeta	Cayman Islands, Jamaica, Central America, Yucatan Peninsula, Ireland, United Kingdom				> 1.5 billion
2020	Cyclone	04/01/20	04/11/20	Cyclone Harold	Solomon Islands, Canuatu, Fiji, Tonga				> 25+ million
2020	Hurricane	10/31/20	11/14/20	Hurricane Eta	Colombia, Jamaica, Central America, Cayman Islands, Cuba, The Bahamas				> 7.9 billion
2020	Hurricane	11/14/20	11/19/20	Hurricane Iota	ABC Islands, Colombia, Jamaica, Central America				> 1.4 billion
2020	Typhoon	11/22/20	11/23/20	Typhoon Goni	Philippines, Vietnam, Cambodia, Laos				> 400+ million
2020	Typhoon	11/08/20	11/15/20	Typhoon Vamco	Philippines, Vietnam, Laos, Thailand				> 400+ million
2020	Wildfire	10/04/20		Lake Ohau Fire	New Zealand	Northwest of Lake Ohau Village			~$25m
2020	Wildfire	02/05/21		Perth Hills Wildfire	Australia	Shire of Mundaring, Shire of Chittering, Shire of Northam City of Swan			~$63m
2021	Earthquake	01/14/21	01/14/21	West Sulawesi	Indonesia				> 58.1 million
2021	Earthquake	02/13/21	02/13/21	Fukushima Prefecture Offshore	Japan				1.3 billion
2021	Tropical Cyclone	05/17/21		Toropical Cyclone Tautae	India				> 25+ million
2021	Tropical Storm	06/19/21	06/23/21	Trophical Storm Claudette	Oaxaca, Veracruz, Atlantic Canada				> 25+ million
2021	Earthquake	06/21/21	06/21/21	China	Yunnan Dali				> 25+ million
2021	Earthquake	06/21/21	06/21/21	China	Southern Qinghai				> 25+ million
2021	Hurricane	07/01/21	07/14/21	Elsa	Lesser Antilles, Greater Antilles, Venezuela, Colombia, Atlantic Canada, Greenland, Iceland				50 million
2021	Typhoon	07/16/21	07/31/21	In-fa (Fabian)	Philippines, Ryukyu Islands, Taiwan, China, North Korea				> 25+ million
2021	Trophical Storm	08/11/21	08/20/21	Fred	Lesser Antilles, Greater Antilles, Southern Quebec, The Maritimes				25 million
2021	Hurricane	08/13/21	08/21/21	Grace	Lesser Antilles, Greater Antilles, Yucatan Peninsula, Central Mexico				513 million
2021	Earthquake	08/14/21	08/14/21		Haiti				1 billion
2021	Hurricane	08/26/21	09/04/21	Ida	Venezuela, Colombia, Jamaica, Cayman Islands, Cuba, Atlantic Canada				> 250 million
2021	Earthquake	09/07/21	09/07/21	Guerrero	Mexico				200 million
2021	Earthquake	09/16/21			China				> 25+ million
2021	Hurricane	09/12/21	09/18/21	Nicholas	Yucatan Peninsula, Tamaulipas				1.1 billion
2021	Hurricane	09/10/21	09/11/21	Larry	Canada				80 million
2021	Cyclone	10/02/21	10/04/21	Cyclone Shaheen	Oman, Iran, India, Pakistan, United Arab Emirates, Saudi Arabia, Yemen				> 25+ million
2021	Earthquake	10/07/21	10/07/21		Japan				> 25+ million
2021	Tropical Storm	10/10/21	10/14/21	Tropical Storm Kompasu	Philippines, Hong Kong, China				245 million
2021	Earthquake	10/16/21	10/16/21		Indonesia				> 25+ million
2021	Tropical Cyclone	10/24/21	11/02/21	Apollo	Italy, Malta, Tunisia, Algeria, Libya, Turkey				> 25+ million
2021	Tropical Storm	10/31/21	11/07/21	Wanda	Atlantic Canada, Bermuda, Azores				> 25+ million
2021	Earthquake	11/14/21	11/14/21		Iran				> 25+ million
2021	Tropical Cyclone	12/14/21	12/18/21	Rai (Odette)	Caroline Islands, Palau, Philippines				> 25+ million
2022	Wildfire	01/15/22	02/28/22	Corrientes	Corrientes Province, Argentina				> 25+ million
2022	Earthquake	03/16/22		Fukushima Earthquake	Japan				2.8 billion
2022	Tropical Storm	04/08/22	04/12/22	Megi	Philippines				>25+ million
2022	Typhoon	08/28/22	09/07/22	Hinnamnor	Japan, Taiwan, Philippines, South Korea, Russian, Far East				>25+ million
2022	Earthquake	09/05/22		Luding Earthquake	Luding County in Sichuan province				>25+ million
2022	Hurricane	09/14/22	09/28/22	Fiona	Leeward Islands, Puerto Rico, Dominican Republic, Lucayan Archipelago, Bermuda, Eastern Canada, Saint Pierre and Miquelon, Greenland				660 million
2022	Hurricane	09/23/22	10/02/22	Ian	Trinidad and Tobago, Venezuela, Colombia, ABC Islands, Jamaica, Cayman Islands, Cuba				> 110 billion
2022	Hurricane	10/07/22	10/10/22	Julia	Trinidad and Tobago, Venezuela, ABC islands, Colombia, Nicaragua, El Salvador, Honduras, Guatemala, Panama, Mexico				>400 million

2023	Wildfire	02/01/23	03/06/23		Chile				>25 million
2023	Earthquake	02/06/23	02/20/23		Turkey, Syria				> 25 million
2023	Cyclone	02/12/23	02/17/23	Gabrielle	New Zealand				> 25 million
2023	Typhoon	05/23/23	05/31/23	Mawar	Guam				> 25 million
2023	Earthquake	06/16/23		France Earthquake	France				> 25 million
2023	Wildfire	08/15/23	09/21/23	Kelowna Wildfire	Canada				> 25 million
2023	Wildfire	08/24/23	09/30/23	Bush Creek Wildfire	Canada				> 25 million
2023	Earthquake	09/08/23			Morocco				> 25 million
2023	Typhoon	07/26/23	08/01/23	Doksuri	Philippines, Taiwan, China, Vietnam				> 25 million
2023	Typhoon	08/26/23	09/03/23	Saola	Eastern Asoa				> 25 million
2023	Typhoon	09/03/23	09/07/23	Haikui	Philippines, Taiwan, China				> 25 million
2023	Typhoon	09/27/23	10/11/23	Koinu	China, Japan, Philippines				>25 million
2023	Hurricane	10/22/23	10/25/23	Otis	Southern Mexico, primarily Guerrero				> 25 million

Source: Munich Re's NAT CAT Service, Swiss Re Sigma and Aon Benfield

Property and Casualty Risk-Based Capital Committee—Release of Recent Report

Ronald Wilkins, MAAA, FCAS
Chairperson
Property and Casualty Risk-Based Capital Committee

Highlights of Recently Issued Report to the NAIC on P&C Underwriting Factors and Investment Income Adjustment (IIA) Factors

November 16, 2023

About the Academy

- The American Academy of Actuaries is a 19,500-member professional association whose mission is to serve the public and the U.S. actuarial profession. For more than 50 years, the Academy has assisted public policymakers on all levels by providing leadership, objective expertise, and actuarial advice on risk and financial security issues.
- The Academy also sets qualification, practice, and professionalism standards for actuaries in the United States.

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Topics Covered Today - Key topics in the August 2023 Report except for payment patterns and the Present Value (PV) method, which were discussed in previous presentations.

- Summary of Results
- Interest Rates
- Adjustment for Catastrophe Risk Captured in R_{Cat}
- Safety Level Calculations
- Minimum Risk Charges and Year-Over-Year Transition Rules
- Calculation of indicated Line 4 and IIA factors from PV indicated risk charges.

Status of Final Report

- On August 30, 2023, the American Academy of Actuaries published on its website a report to the NAIC P&C RBC Working Group: Update to P&C RBC Underwriting Factors and Investment Income Adjustment Factors

Please refer to the final report for explanations of the methodology and implications of the analysis which produced the results presented here.

Indicated Changes in Risk Charges by Line

(1)	Premium Risk			Reserve Risk		
	(2)	(3)	(4)= (3)/(2)-1	(5)	(6)	(7)= (6)/(5)-1
LOB	Risk Charge		Change in	Risk Charge		in Risk
	Current	Indicated	Risk Chg	Current	Indicated	Chg
A-HO	0.182	0.188	3.0%	0.138	0.166	20.4%
B-PPA	0.125	0.137	10.1%	0.094	0.129	37.2%
C-CA	0.185	0.201	9.1%	0.162	0.259	**59.7%**
D-WC	0.138	0.126	-8.8%	0.116	0.082	**-28.9%**
E-CMP	0.148	0.160	8.7%	0.309	0.325	5.1%
F1-MPL-O	0.534	0.363	**-32.0%**	0.196	0.094	**-51.9%**
F2-MPL-C	0.189	0.244	**28.8%**	0.127	0.050	**-60.5%**
G-SL	0.166	0.164	-1.1%	0.161	0.238	**48.5%**
H-OL	0.130	0.135	3.5%	0.304	0.293	-3.9%
I-SP	0.120	0.062	**-48.5%**	0.204	0.213	4.8%
J-APD	0.044	0.050	**13.0%**	0.127	0.112	-12.0%
K-Fid/Sur	0.272	0.105	**-61.2%**	0.289	0.440	**52.4%**
L-Other	0.142	0.143	1.2%	0.180	0.147	-18.4%
M-Intl	0.556	0.804	**44.7%**	0.188	0.852	**353.6%**
N-Re-Prop	0.312	0.162	**-48.3%**	0.275	0.204	-25.7%
O-Re-Liab	0.295	0.227	**-23.2%**	0.388	0.266	**-31.5%**
R-PL	0.307	0.286	-6.9%	0.515	1.013	**96.6%**
S-FG/MG	0.754	1.534	**103.5%**	0.092	0.050	**-45.8%**
T-Wrnty	0.030	0.215	**617.5%**	0.289	0.302	4.6%
Total/Avg	0.135	0.133	-1.7%	0.195	0.202	3.5%

Indicated Changes in ACL by Type of Company

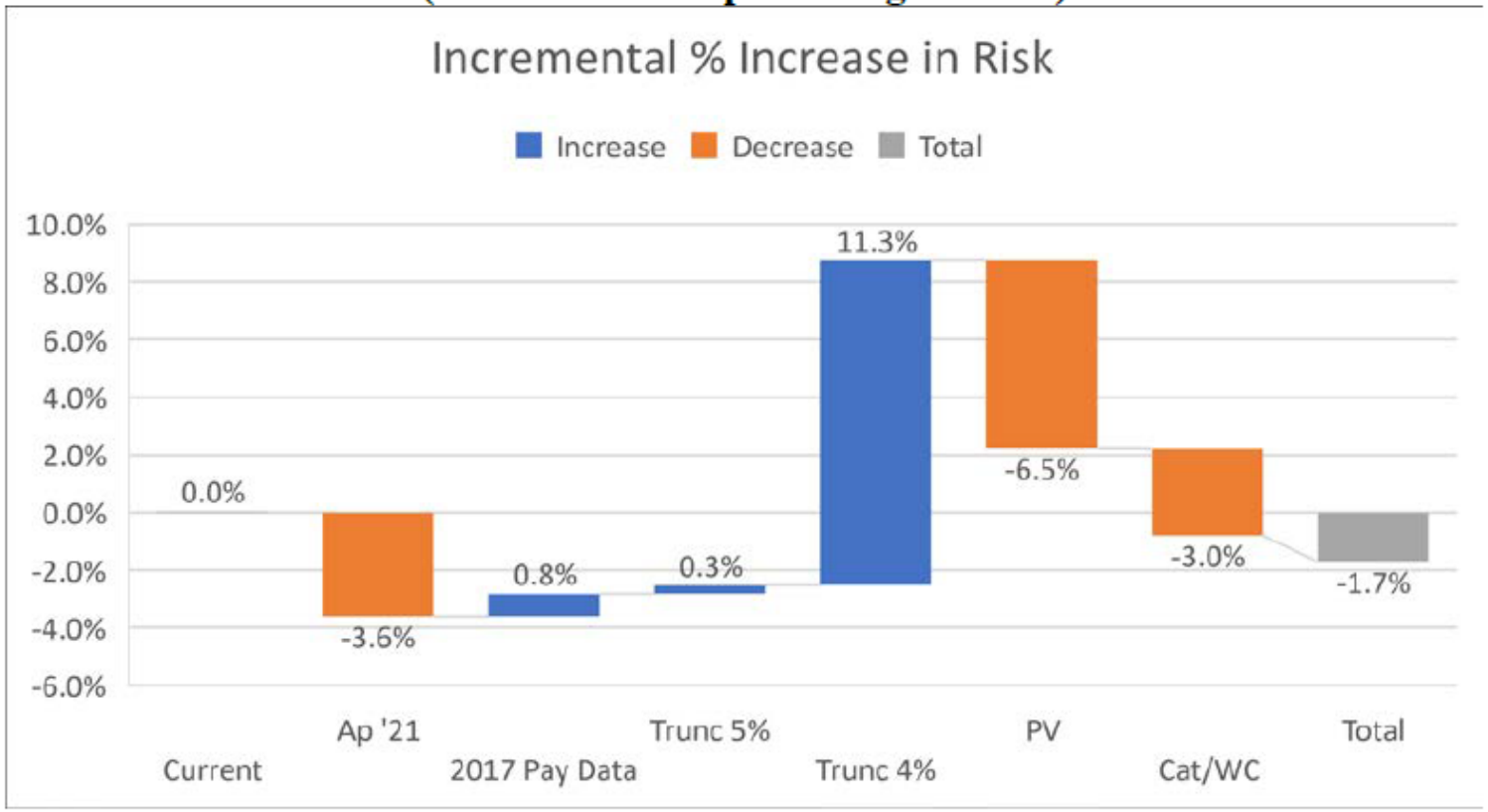
(1)	(2)	(3)	(4)	(5)	(6)
			% Change in:		
Row	Type of Company	ACL Value with 2019 Risk Charges ($Billions)	Reserve Risk Charge	Premium Risk Charge	ACL
1	Commercial	64.9	4.8%	-4.5%	2.1%
2	Med Prof Liab	2.4	-52.2%	4.8%	-14.3%
3	NOC	0.9	21.3%	-17.6%	1.4%
4	Personal	84.3	12.4%	4.2%	1.6%
5	Reinsurance	8.2	-18.6%	-23.5%	-2.2%
6	Workers Comp	10.1	-9.7%	-2.9%	-4.8%
7	Total	170.6	3.4%	-0.8%	1.0%

Distribution of Number of Companies by Indicated Change in ACL Values

(1)	(2)	(3)
% Changes in ACL RBC	# companies	% companies
Less Than -50%	9	0%
-50% to -25%	96	5%
-25% to -15%	117	6%
-15% to -5%	194	11%
-5% to 5%	951	52%
5% to 15%	298	16%
15% to 25%	95	5%
25% to 50%	71	4%
Over 50%	6	0%
Total	1,837	100%

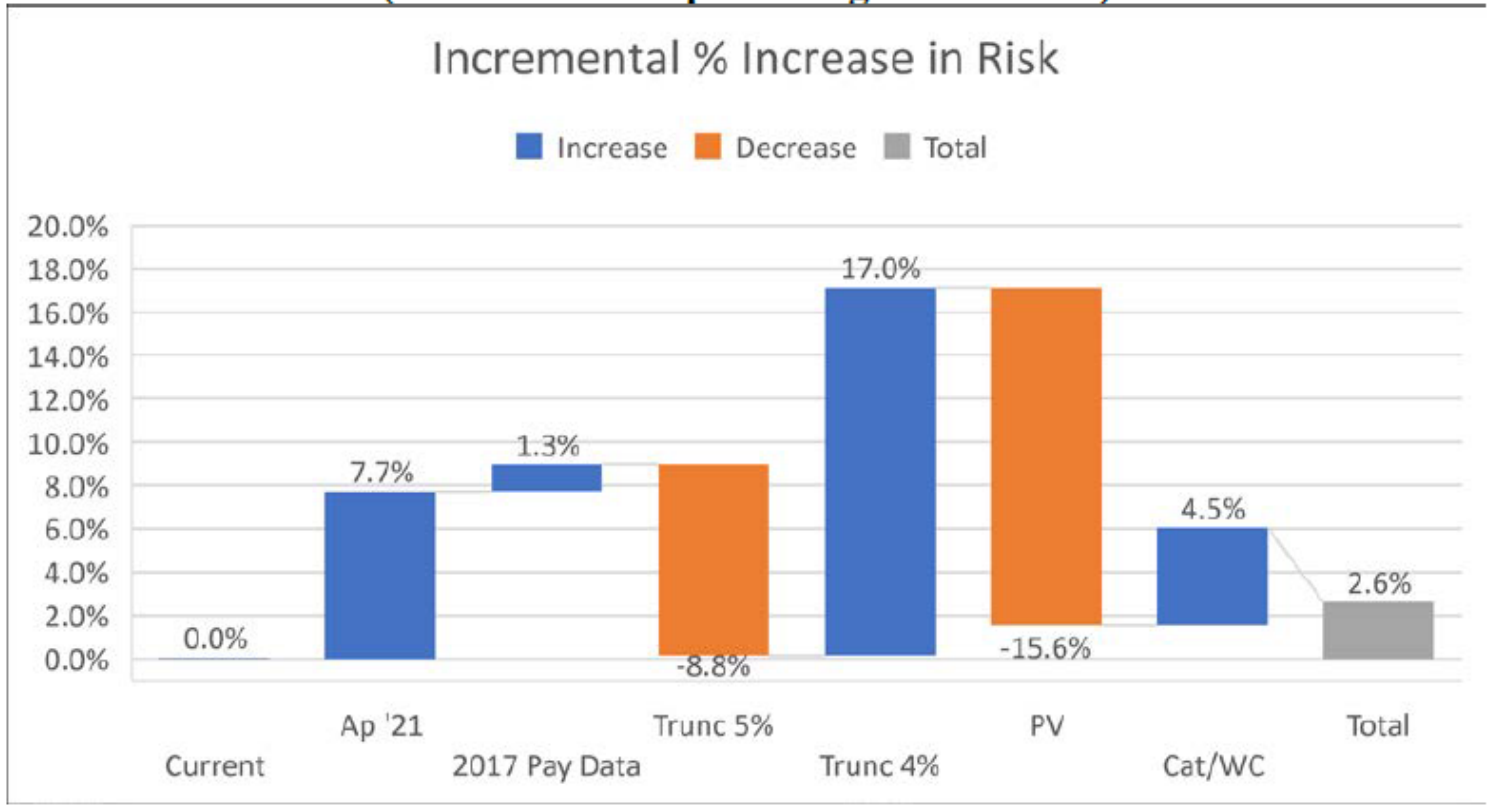
Summary of Movements in Indicated Risk Charges

Table 2.3A
Premium Risk: Movement in Indicated Risk Charge with Assumption Changes Listed in Table 2.2
(Movement as a percentage of risk)



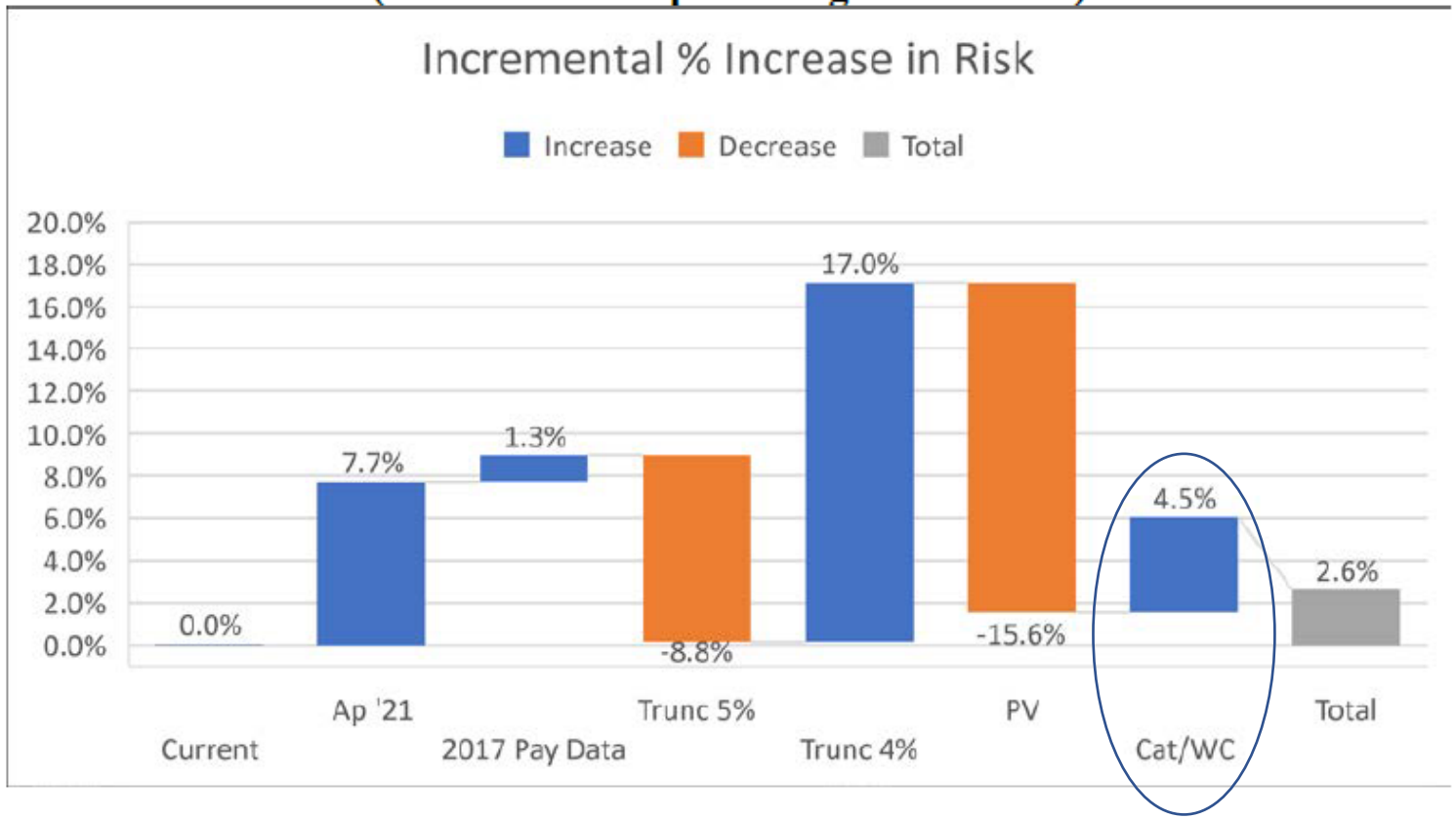
Summary of Movements in Indicated Risk Charges

Table 2.3B
Reserve Risk: Movement in Indicated Risk Charge with Assumption Changes Listed in Table 2.2
(Movement as a percentage of reserves)



Summary of Movements in Indicated Risk Charges

Table 2.3B
Reserve Risk: Movement in Indicated Risk Charge with Assumption Changes Listed in Table 2.2 (Movement as a percentage of reserves)



Notes on Workers' Compensation Tabular Reserve Adjustment

- Consider extending the scope of PR038, which includes certain medical tabular discount information, to all areas of discount.
- Review the variability of WC tabular discount among companies and the extent to which that affects the comparability of TAC among companies.
- We use this adjustment, but we note that it may not be correct for any company. For companies that do not discount, no adjustment is necessary, and the risk charge should be 4.6%, not 8.2%. For companies that do discount, the effect of the discount is likely to be more than 3.4%, so for them, the adjusted risk charge should be more than 8.2%.

Summary of Movements in Indicated Risk Charges

Table 2.4A
Premium: Indicated Risk Charges by LOB
According to Movement in Indicated Risk Charge by Analysis Element Shown in Table 2.2
Listed in Order of Decreasing Total Indicated Change

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LOB	Assumption Set							Tot Chg (8)/(2)-100%
	Current	Ap '21	2017 Pay Data	Trunc 5%	Trunc 4%	PV	Cat/WC	
T-Wrnty	3.0%	13.9%	20.2%	20.0%	20.6%	21.6%	21.6%	619.0%
S-FG/MG	75.4%	162.9%	169.5%	162.1%	167.7%	153.4%	153.4%	103.5%
M-Intl	55.6%	98.8%	99.1%	100.4%	103.1%	94.3%	80.4%	44.7%
F2-MPL-C	18.9%	20.5%	21.7%	21.9%	25.2%	24.4%	24.4%	29.0%
J-APD	4.4%	4.5%	4.5%	4.8%	5.2%	5.4%	4.9%	10.6%
B-PPA	12.5%	13.0%	13.0%	12.8%	14.2%	13.7%	13.7%	10.3%
C-CA	18.5%	19.5%	19.3%	18.7%	20.9%	20.1%	20.1%	9.1%
E-CMP	14.8%	14.4%	15.0%	15.3%	16.8%	15.9%	16.1%	9.0%
H-OL	13.0%	13.1%	14.0%	13.0%	16.2%	13.5%	13.5%	3.8%
A-HO	18.2%	17.8%	18.0%	18.2%	18.9%	18.6%	18.8%	3.2%
L-Other	14.2%	14.0%	13.8%	14.1%	15.0%	14.3%	14.3%	1.2%
G-SL	16.6%	17.9%	19.3%	19.2%	20.7%	18.9%	16.4%	-1.4%
R-PL	30.7%	31.3%	32.1%	32.2%	37.0%	28.6%	28.6%	-6.8%
D-WC	13.8%	12.6%	11.9%	12.3%	15.2%	12.0%	12.5%	-9.1%
O-Re-Liab	29.5%	24.0%	26.4%	27.9%	32.0%	23.0%	22.7%	-23.0%
F1-MPL-O	53.4%	39.0%	37.3%	39.1%	45.0%	36.3%	36.3%	-32.1%
N-Re-Prop	31.2%	31.3%	30.6%	32.6%	34.6%	33.5%	16.1%	-48.4%
I-SP	12.0%	7.5%	7.2%	7.3%	8.2%	7.9%	6.2%	-48.4%
K-Fid/Sur	27.2%	10.2%	11.2%	10.3%	11.5%	10.6%	10.6%	-61.0%
Total/Avg	13.5%	13.0%	13.1%	13.2%	14.7%	13.7%	13.3%	-1.7%

Summary of Movements in Indicated Risk Charges

Table 2.4B
Reserves: Indicated Risk Charges by LOB
According to Movement in Indicated Risk Charge by
Analysis Element Shown in Table 2.2
Listed in Order of Decreasing Total Indicated Change

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LOB	Assumption Set							Tot Chg (8)/(2)-100%
	Current	Ap '21	2017 Pay Data	Trunc 5%	Trunc 4%	PV	Cat/WC	
M-Intl	18.8%	78.7%	90.6%	81.6%	85.7%	85.1%	85.1%	353.5%
R-PL	51.5%	107.9%	104.7%	105.9%	113.1%	101.3%	101.3%	96.6%
C-CA	16.2%	24.0%	24.4%	24.1%	26.3%	25.9%	25.9%	59.5%
K-Fid/Sur	28.9%	50.4%	52.9%	42.5%	45.6%	44.0%	44.0%	52.5%
G-SL	16.1%	25.9%	27.9%	24.5%	27.5%	23.9%	23.9%	48.8%
B-PPA	9.4%	11.5%	11.2%	11.0%	12.7%	12.9%	12.9%	37.6%
A-HO	13.8%	14.7%	15.3%	15.1%	16.4%	16.6%	16.6%	20.4%
E-CMP	30.9%	31.3%	34.2%	32.7%	35.7%	32.5%	32.5%	5.2%
I-SP	20.4%	23.4%	23.5%	20.6%	21.9%	21.3%	21.3%	4.6%
T-Wrnty	28.9%	23.4%	28.1%	24.9%	26.1%	30.2%	30.2%	4.6%
H-OL	30.4%	30.1%	31.3%	29.8%	33.9%	29.2%	29.2%	-4.0%
J-APD	12.7%	10.5%	10.4%	10.2%	10.8%	11.2%	11.2%	-12.1%
L-Other	18.0%	18.5%	18.0%	13.0%	14.7%	14.7%	14.7%	-18.5%
N-Re-Prop	27.5%	21.0%	21.4%	21.2%	23.5%	20.4%	20.4%	-25.7%
D-WC	11.6%	10.8%	10.5%	6.7%	11.3%	4.6%	8.2%	-29.2%
O-Re-Liab	38.8%	37.1%	37.2%	31.3%	36.9%	26.5%	26.5%	-31.6%
F1-MPL-O	19.6%	9.4%	7.6%	6.9%	10.4%	9.4%	9.4%	-52.1%
F2-MPL-C	12.7%	-3.4%	-3.0%	-3.6%	-1.3%	-0.9%	-0.9%	-106.9%
S-FG/MG	9.2%	-7.3%	-4.2%	-10.0%	-8.2%	-5.0%	-5.0%	-154.9%
Total/Avg	19.5%	21.1%	21.3%	19.4%	22.7%	19.2%	20.1%	2.6%

Interest Rates

US Treasury average per annum interest rates

A. Date Range	3 Year	5 Year
2018	2.6%	2.7%
2019	1.9%	2.0%
2020	0.4%	0.5%
2021	0.5%	0.9%
2022	3.0%	3.0%
Jan - June 2023	4.0%	3.7%
Jan-Oct 2023	4.3%	4.0%
B. Monthly 2023	**3 Year**	**5 Year**
Jan-23	3.9%	3.6%
Feb-23	4.2%	3.9%
Mar-23	4.1%	3.8%
Apr-23	3.8%	3.5%
May-23	3.8%	3.6%
Jun-23	4.3%	3.9%
Jul-23	4.5%	4.1%
Aug-23	4.6%	4.3%
Sep-23	4.7%	4.5%
Oct-23	4.9%	4.8%

- To choose the updated IIA interest rate for this analysis, we might follow what appears to be the method used in the 1990s. As such, we would make a conservative selection considering current interest rates and longer-term trends.
- Looking at 2023 through October 31 a rate of 4% might be appropriate. However, if we had followed the same method at years ended 2018 through 2022, we would have indicated interest rates ranging from 0.5% to 3%.
- An alternative calibration method we use in this Report recognizes that risk factors tend to increase when interest rates increase and vice versa and selects a combined indicated risk charge rather than selecting separate risk factors and IIAs. When we apply the alternative method, our indicated risk charges are largely independent of interest rate forecasts.
- To separate the indicated risk charges into its risk factor and IIA elements, for all lines of business (LOBs), we use a 4% interest rate. The risk charges are not sensitive to the 4% interest rate choice.

Premium Risk—Catastrophe Adjustments

- Beginning with year-end 2017 reporting, the RBC Formula includes a new risk component, R_{CAT}, covering hurricane and earthquake components of the total premium risk.
- The Line 4 premium risk factors are based on data that includes hurricane and earthquake claims. Therefore, there is a potential duplication between the Line 4 risk factors and R_{CAT}. To remove that overlap, for the 2017 RBC Filings, the NAIC reduced the otherwise applicable Line 4 factor by an amount we call the catastrophe adjustment.
- The analysis documented in the August 2023 Report is the first Academy review of the catastrophe adjustment.
- Regulators provided us with summarized and blinded catastrophe and non-catastrophe data from confidential RBC Filings for this purpose.
- We evaluated the portion of risk charges related to catastrophes for the years where we have catastrophe data (AYs 2004-2017). We evaluated the extent to which those years are representative of the 1988-2017 experience period this Report uses to calibrate risk charges.
- We produced indicated catastrophe adjustments (see next slide).

Premium Risk—Catastrophe Adjustments

(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)
LOB	Current Cat Adjustment	Data 87.5th Total LR	Data 87.5th Non Cat LR	(3)-(4) Indicated Cat Adjustment	Selected Cat Adjustment		(3)+exp-100% 87.5th Total Risk Charge	(6)/(7) Cat Adj As % of Risk Charge
A-HO	2.8%	91.5%	88.9%	2.6%	2.6%		20.4%	12.7%
E-CMP	1.8%	83.3%	81.7%	1.6%	1.6%		18.9%	8.6%
G-SL	1.6%	96.0%	91.7%	4.3%	4.3%		29.8%	14.4%
I-SP	1.6%	82.8%	79.4%	3.4%	3.4%		12.9%	26.3%
J-APD	0.0%	84.8%	84.2%	0.6%	0.6%		8.0%	7.5%
M-Intl	0.0%	192.1%	159.3%	32.8%	15.0%		136.0%	11.0%
N-Re-Prop	6.9%	122.1%	96.2%	25.9%	25.9%		48.8%	53.0%
O-Re-Liab	0.0%	100.5%	100.2%	0.4%	0.4%		27.2%	1.3%
R-PL	0.0%	100.8%	100.6%	0.3%	0.0%		33.8%	0.0%

Premium Risk—Catastrophe Adjustments

- For J-APD, the Lines 1 to 3 calculations of PR018 (which compare the company historical loss ratio to the industry historical loss ratio) use total losses, including catastrophe losses. For other LOBs with catastrophe adjustments, the calculations in Lines 1 to 3 use losses excluding the company catastrophe losses. As the data shows catastrophe losses for J-APD, it might be appropriate to make the J-APD calculations for Lines 1 to 3 of PR018 the same as for the other LOBs with catastrophe exposure.
- A key assumption in our analysis is that the hurricane and earthquake modeling includes reasonable provisions for all losses of the types that are reported in the catastrophe experience. The NAIC should consider the extent to which the modeling is sufficiently comprehensive.
- We observed unexpected differences in indicated undiscounted risk charges between Annual Statement data and RBC data. That may be an issue related to the early-year use of the RBC forms PR101, etc., for reporting historical hurricane and earthquake loss experience. The NAIC should consider whether differences can be investigated.

Statistical Safety Level in RBC

- Setting the safety level for the P&C RBC formula is a policy decision for regulators.
- The indicated company action level risk charges in the August 2023 Report are based on the 87.5th percentile safety level.
- The August 2023 Report shows the impact of using various safety levels in RBC.
- Preliminary impacts of higher safety levels on indicated risk charges (compared to 87.5 percentile)
    - 90th percentile safety level increases premium risk charges about 25%, reserve risk charges about 40%.
    - 95th percentile safety level increases premium risk charges about 120% and reserve risk charges about 180%.
- Considerations for not changing the safety level:
    - Capital required for a loss development runoff time horizon of nine years is more than that required by some regulatory solvency formulas which utilize a one-year development horizon.
    - Past analysis has shown that larger companies, who cover most policyholders, have lower indicated risk charges than smaller and mid-sized companies, implying a higher safety level for most policyholders.
- Considerations for increasing the safety level
    - 87.5% is lower than the safety level in any other component of the RBC Formula or, to our knowledge, in regulatory capital formulas in other countries (e.g., Rcat=99%, Bond Factors=96%).
    - Risk charges have declined over time, concurrent with interest rates. But there is no reason to expect a continuation of the downward trend in risk.
    - Years prior to 1988, with poor experience, have been excluded from the analysis and deserve some consideration.
    - Captives and runoff companies may now rely on regulatory capital requirements more, making the setting of regulatory capital more important.

Indicated Risk Charges at Various Safety Levels

Table 9.1A
Premiums: Indicated Risk Charges at Various Safety Levels

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LOB	Current Risk Charge	PV Indicated risk Charges Premium			(4)/(2)-1	(4)/(3)-1	(5)/(3)-1
		87.5th	90th	95th	90 v current	90 v 87.5	95 v 87.5
A-HO	18.2%	18.8%	21.9%	34.0%	20%	17%	81%
B-PPA	12.5%	13.7%	16.2%	24.6%	30%	18%	79%
C-CA	18.5%	20.1%	24.2%	38.3%	31%	20%	90%
D-WC	13.8%	12.5%	16.1%	27.2%	17%	29%	117%
E-CMP	14.8%	16.1%	19.1%	29.5%	29%	19%	84%
F1-MPL-O	**53.4%**	36.3%	42.9%	69.3%	-20%	18%	91%
F2-MPL-C	18.9%	24.4%	30.0%	46.4%	58%	23%	90%
G-SL	16.6%	16.4%	22.4%	30.1%	35%	37%	84%
H-OL	13.0%	13.5%	19.1%	39.0%	47%	41%	188%
I-SP	**12.0%**	6.2%	9.5%	23.3%	-21%	**54%**	**275%**
J-APD	4.4%	4.9%	7.3%	15.4%	66%	**51%**	217%
K-Fid/Sur	**27.2%**	10.6%	16.0%	35.8%	-41%	**51%**	**238%**
L-Other	14.2%	14.3%	18.8%	35.8%	33%	31%	150%
M-Intl	55.6%	80.4%	117.5%	184.4%	**111%**	46%	129%
N-Re-Prop	**31.2%**	16.1%	24.0%	57.0%	-23%	49%	**254%**
O-Re-Liab	29.5%	22.7%	31.0%	54.5%	5%	36%	140%
R-PL	30.7%	28.6%	40.4%	91.8%	31%	41%	221%
S-FG/MG	75.4%	153.4%	177.7%	374.0%	**136%**	16%	144%
T-Wrnty	3.0%	21.6%	28.9%	37.4%	**862%**	34%	73%
Avg	13.5%	13.3%	16.7%	28.8%	24%	26%	117%

- We can use Table 9.1 to assess how adequate/inadequate current risk charges are from an implied safety level perspective. In column 2, we mark LOBs where the current risk charges are above the 90th indicated percentile level (yellow and bold) or within 10% of the 90th percentile level (yellow but not bold). These are the LOBs where current risk charges are particularly high relative to an 87.5th percentile safety level.

Indicated Risk Charges at Various Safety Levels

Table 9.1B
Reserves: Indicated Risk Charges at Various Safety Levels

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LOB	Current Risk Charge	PV Indicated risk Charges			(4)/(2)-1	(4)/(3)-1	(5)/(3)-1
		Reserve			90 v current	90 v 87.5	95 v 87.5
		87.5th	90th	95th			
A-HO	13.8%	16.6%	22.6%	47.0%	64%	36%	184%
B-PPA	9.4%	12.9%	17.8%	35.7%	89%	37%	176%
C-CA	16.2%	25.9%	32.4%	60.0%	99%	*25%*	*132%*
D-WC	11.6%	8.2%	12.8%	28.4%	10%	56%	247%
E-CMP	30.9%	32.5%	39.9%	72.1%	29%	*23%*	*122%*
F1-MPL-O	19.6%	9.4%	16.2%	40.4%	*-17%*	72%	330%
F2-MPL-C	12.7%	-0.9%	4.6%	24.7%	*-64%*	NM	NM
G-SL	16.1%	23.9%	30.7%	60.3%	91%	29%	152%
H-OL	30.4%	29.2%	39.1%	73.1%	28%	34%	150%
I-SP	20.4%	21.3%	31.6%	66.9%	55%	48%	214%
J-APD	12.7%	11.2%	20.5%	59.3%	61%	84%	430%
K-Fid/Sur	28.9%	44.0%	69.8%	144.1%	142%	58%	227%
L-Other	18.0%	14.7%	22.5%	54.8%	25%	54%	274%
M-Intl	18.8%	85.1%	113.8%	423.1%	506%	34%	397%
N-Re-Prop	27.5%	20.4%	28.9%	59.8%	5%	42%	193%
O-Re-Liab	38.8%	26.5%	39.1%	88.2%	1%	47%	232%
R-PL	51.5%	101.3%	128.0%	231.3%	148%	*26%*	*128%*
S-FG/MG	9.2%	-5.0%	-1.5%	36.3%	*-116%*	NM	NM
T-Wrnty	28.9%	30.2%	46.2%	262.0%	60%	53%	768%
Avg	19.5%	20.1%	27.5%	55.2%	41%	37%	175%

- For F2-MPL-C and S-FG/MG, for reserve risk, comparisons of 90th and 95th percentile safety levels to the 87.5th percentile safety level are not meaningful (NM) because the 87.5th percentile indicated risk charge is negative.
- Negative indicated risk charges arise when the investment income projected by the IIA is larger than the undiscounted risk charge.
- In those cases, the risk charge would be increased to a minimum selected by the NAIC.

Minimum Risk Charges and Year-Over-Year Capping Approaches

- Imposing transition rules and a minimum risk charge are decisions for regulators. Calculations shown in the August 2023 Report related to transition rules and minimum risk charges are only illustrative.
- We have considered a minimum risk charge of 5%, consistent with the current lowest risk charge.
- We looked at various capping approaches to limit changes in risk charge over one year to +/- 10%, 20%, or 35%, values which the committee has reviewed in the past.
- These risk charge limits are calculated line by line assuming a company with LOB expense ratio equal to the industry expense ratios and assuming no company loss experience adjustment.
- The next three slides illustrate transition rules and minimum risk charges, while showing the calculation of indicated Line 4 and IIA factors from PV indicated risk charges.

Calculation of Line 4 and IIA Factors – Part A

Table 10.1
Sample Calculation of Line 4 and Line 7/8 Factors

Row	Step	LOB			
		Premium Risk		Reserve Risk	
		A-HO	F2-MPL-C	A-HO	F2-MPL-C
A. Indicated Line 4 and IIA Factors					
1	Indicated Risk Charge-PV Approach; Gross of Cat; Including risk development horizon and WC tabular adjustments (Appendix 5 Exhibit A5-1A, 1B, col 7).	21.3%	24.4%	16.6%	-0.9%
2	Expense Ratio (Table 1.1A, column 2)	28.9%	25.5%	NA	NA
3	IIAs- 40-year runoff payment pattern; 4% interest; (Exhibit A2-5A and 5B; Also Table 1.1)	0.966	0.863	0.951	0.896
4	Indicated Line 4 Factor Gross of Cat Prem: (4) = (1.0+(1)-(2))/(3) Reserve: (4)=(1.0+(1))/(3)-1.0	0.956	1.146	22.6%	10.6%
5	Indicated Catastrophe Adjustment (Table 7.1, column 6)	2.6%	NA	NA	NA
6	Indicated Line 4 Factor Net of Cat (6)=(4)-(5)	0.930	1.146	0.226	0.106

- The calibration method (PV method) used in the 2023 Report recognizes that risk factors tend to increase when interest rates increase and vice versa and selects a combined indicated risk charge rather than selecting separate risk factors and IIAs. The purpose of Table 10.1 is to show the calculation of indicated Line 4 and IIA factors from PV indicated risk charges. This is necessary so that Line 4 and IIA factors will be available for the RBC formula template.

- Row 3: IIAs based on the 40-year runoff payment pattern by LOB and a 4% interest rate. We use the 40-year runoff payment pattern rather than the 40-year truncated payment pattern. We use the 40-year truncated payment pattern to put the RDHA into the overall risk charge (see page 47 of Report). However, the runoff payment pattern better presents the actual investment income potential. Using the runoff payment pattern for IIAs makes the risk factors higher than they would be with the truncated payment pattern. That is correct because the RDHA is an increase in the risk factor.

- The indicated risk charges in row 1 do not include any transition limitations. In the past, the NAIC limited the maximum change in any LOB risk factor in any year to a set amount. We believe that is a good practice. The maximum change per year is a policy matter for the NAIC. The August 2023 Report does not show the effect of limits, other than the 10% example in Table 10.1, Part C.

- Row 6 is the value to be used in the RBC Formula, absent the application of minimums and transition rules.

Calculation of Line 4 and IIA Factors – Part B

Table 10.1
Sample Calculation of Line 4 and Line 7/8 Factors

Row	Step	LOB			
		Premium Risk		Reserve Risk	
		A-HO	F2-MPL-C	A-HO	F2-MPL-C
A. Indicated Line 4 and IIA Factors					
1	Indicated Risk Charge-PV Approach; Gross of Cat; Including risk development horizon and WC tabular adjustments (Appendix 5 Exhibit A5-1A, 1B, col 7).	21.3%	24.4%	16.6%	-0.9%
2	Expense Ratio (Table 1.1A, column 2)	28.9%	25.5%	NA	NA
3	IIAs- 40-year runoff payment pattern; 4% interest; (Exhibit A2-5A and 5B; Also Table 1.1)	0.966	0.863	0.951	0.896
4	Indicated Line 4 Factor Gross of Cat Prem: (4) = (1.0+(1)-(2))/(3) Reserve: (4)=(1.0+(1))/(3)-1.0	0.956	1.146	22.6%	10.6%
5	Indicated Catastrophe Adjustment (Table 7.1, column 6)	2.6%	NA	NA	NA
6	Indicated Line 4 Factor Net of Cat (6)=(4)-(5)	0.930	1.146	0.226	0.106
B. Illustration of Minimum Risk Charges					
7	Indicated Risk Charge Net of Cat Prem: (6)*(3)+(2)-1.0 Reserve: (1.0+(6))*(3)-1.0	18.8%	24.4%	16.6%	-0.9%
8	Max of 5.0% and row (7)	18.8%	24.4%	16.6%	5.0%
9	Indicated Line 4 Factor Net of Cat, after minimum Prem: (9) = (1.0+(8)-(2))/(3) Reserve: (9)=(1.0+(8))/(3)-1.0	0.930	1.146	22.6%	17.2%

- Rows 7-9 illustrate how we calculate the Line 4 factor when applying a 5% minimum risk charge. This is only illustrative - imposing a minimum risk charge is a decision for regulators.
- Row 7: Risk charge net of catastrophes. We calculate this by applying the risk charge formula to row 6, the indicated Line 4 risk factor net of the indicated catastrophe adjustment.
- Row 8: Indicated risk charge equals the maximum of the indicated risk charge from row 7, or the selected minimum, 5% in this example. The minimum applies to the risk charge after catastrophe adjustment.
- Row 9: Converts the risk charge in row 8 to the Line 4 risk factor. For any LOB with a risk charge already 5.0% or greater, row 9 = row 6.

Calculation of Line 4 and IIA Factors – Part C

Row	Step	LOB			
		Premium Risk		Reserve Risk	
		A-HO	F2-MPL-C	A-HO	F2-MPL-C
B. Illustration of Minimum Risk Charges					
7	Indicated Risk Charge Net of Cat Prem: (6)*(3)+(2)-1.0 Reserve: (1.0+(6))*(3)-1.0	18.8%	24.4%	16.6%	-0.9%
8	Max of 5.0% and row (7)	18.8%	24.4%	16.6%	5.0%
9	Indicated Line 4 Factor Net of Cat, after minimum Prem: (9) = (1.0+(8)-(2))/(3) Reserve: (9)=(1.0+(8))/(3)-1.0	0.930	1.146	22.6%	17.2%
C. Illustration of application of transition rules with maximum changes					
10	2022 Risk Factor, net of cats (Table 1.1 column 2)	0.936	1.130	0.213	0.276
11	2022 IIA (Table 1.1)	0.954	0.827	0.938	0.883
12	2022 Risk Charge (Net of Cats) Prem: (10)*(11)+(2)-1.0 Reserve: (1.0+(10))*(11)-1.0	18.2%	18.9%	13.8%	12.7%
13	Indicated change in risk charge (net of cats) (12)/(7)-100%	3.2%	29.0%	20.4%	-106.9%
14	Line 13 subject to Maximum increase 10.0% Maximum decrease -10.0%	3.2%	10.0%	10.0%	-10.0%
15	Indicated risk charge after transition limitations; subject to 5% minimum Max((1.0+(14))*(12), 5%)	18.8%	20.8%	15.2%	11.4%
16	Indicated Line 4 Factor Net of Cat After Transition Caps and Minimum Prem: (1.0+(15)-(2))/(3) Reserve: (1.0+(15))/(3)-1.0	0.930	1.105	0.211	0.243

- Rows 10-16 illustrate how we calculate the Line 4 factor when applying a maximum increase/decrease of 10% in risk charge. This is only illustrative - imposing transition rules is a decision for regulators.
- Rows 10, 11: Show the current (2022) RBC Formula Line 4 and IIA factors, respectively.
- Row 12: We calculate the risk charge implied by the 2022 Line 4 and IIA factors.
- Row 13: The change in risk charge from the 2022 risk charge to the indicated risk charge = (row 7) / (row 12)) – 1.0.
- Row 14 = Row 13 but limited to reflect the selected transition maximum increase and decrease (+/-10% in this illustration).
- Row 15: Indicated risk charge after transition caps and minimum risk charge.
- Row 16: Line 4 factor after transition caps and minimum risk charge.

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Report to the National Association of Insurance Commissioners Property and Casualty Risk-Based Capital (E) Working Group

Update to Property and Casualty Risk-Based Capital Underwriting Factors and Investment Income Adjustment Factors

Presented by the American Academy of Actuaries[1]
Property and Casualty Risk-Based Capital Committee

August 30, 2023

[1] The American Academy of Actuaries is a 19,500-member professional association whose mission is to serve the public and the U.S. actuarial profession. For more than 50 years, the Academy has assisted public policy makers on all levels by providing leadership, objective expertise, and actuarial advice on risk and financial security issues. The Academy also sets qualification, practice, and professionalism standards for actuaries in the United States.

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The analysis and conclusions in this Report reflect the opinions of the committee members and do not necessarily reflect the views of their employers or the actuarial organizations in which they are members.

Contents

1. BACKGROUND & RESULTS

Background

The American Academy of Actuaries Property and Casualty Risk-Based Capital Committee ("Committee" or "We") prepared this Report ("Report") at the request of the National Association of Insurance Commissioners' ("NAIC") Property and Casualty (P&C) Risk-Based Capital (RBC) Working Group ("NAIC Working Group" or "Working Group").

In this Report, we evaluate indicated Investment Income Adjustment (IIA) factors by Line of Business ("LOB") for the Underwriting (UW) Risk elements of the P&C RBC Formula ("RBC Formula" or "Formula"), specifically, RBC Line 8 on page PR017 (R4 UW Risk—Reserves) and Line 7 on page PR018 (R5 UW Risk—Net Written Premium). We refer to these as the "IIA Factors," "IIAs," or "Line 7/8 Factors."[2]

The IIAs were last revised for use in the 2013 RBC Formula. That revision reflected updated payment pattern data but did not examine the payment pattern methodology or the 5% interest rate in effect since the inception of the RBC Formula. This Report considers all elements of the IIAs.

In evaluating the IIA Factors in this Report, we also review the LOB UW risk factors, i.e., Line 4 on pages PR017 and PR018 for the RBC Formula. We refer to these as "Risk Factors" or "Line 4 Factors." The Line 4 factors in the RBC Formula were last revised for use in the 2019 RBC Formula.

This Report is Report 2 in a series of three reports we described to the NAIC Working Group in May 2019:

- Report 1: Indicated risk factors. We provided Report 1 to the Working Group in March 2021 and revised it in April 2021 ("April 2021 Report"[3]).
- Report 2: Indicated IIA factors. In addition to developing indicated Line 7/8 IIA factors, in this Report, we revise the Line 4 factors presented in Report 1.
- Report 3: Loss Concentration Factor ("LCF") and Premium Concentration Factor ("PCF")—RBC Line 14 on pages PR017 and PR018, respectively, for which work is underway.

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[2] "PR017" and "PR018" refer to pages in the 2022 NAIC P&C RBC Formula forms, which insurers file annually on a confidential basis.

[3] American Academy of Actuaries Property and Casualty Risk-Based Capital Committee, "Report to the National Association of Insurance Commissioners Property and Casualty Risk-Based Capital (E) Working Group Update to Property and Casualty Risk-Based Capital Underwriting Factors Experience Through December 31, 2017," Presented March 2021 (Revised April 21, 2021).

The analysis presented in this Report uses the same insurance industry data as Report 1, issued in April 2021, i.e., data evaluated through December 31, 2017.[4] The Report uses economic data through June 30, 2023.

Indicated Risk Charges

Tables 1.1, 1.2, and 1.3 below show the results of our analysis.

Table 1.1: Current and Indicated Premium and Reserve Risk Charges

Tables 1.1A and 1.1B show the current and indicated[5] Line 4 factors, the IIAs, and the risk charges by LOB and for all LOBs combined, for premium risk and reserve risk, respectively. The risk charges represent the combined effect of Line 4 factors and IIAs. We highlight the LOBs with the five largest increases and the five largest decreases.

The all-line average change in risk charge in the tables is -1.7% for premium risk and +3.5% for reserve risk, respectively. Those average indicated changes are small, but there are large changes for individual LOBs. Many of those large changes were identified in the April 2021 Report.

[4] Substantial work is involved in data preparation for the three analyses in the May 2019 letter to the NAIC. Therefore, we planned to produce the three reports with the same data. While Reports 1 and 2 have taken longer than we anticipated, adding additional data was not clearly beneficial as (a) processing additional data would have delayed this report, (b) the data includes 38 AYs, 1980-2017, so the effect of adding a small number of years, unless they identify new trends, is likely to be low, and (c) additional data through 2020, for example, would include the initial COVID-affected years, but not the full cycle of COVID emergence in favorable and unfavorable impacts on loss ratio and reserve development.

[5] Indicated risk charges mean the values produced with the methods and assumptions described in this Report. The NAIC is responsible for deciding the extent to which those are suitable for the RBC Formula.

Table 1.1A
Premium Risk: Current and Indicated RBC Factors

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)= (9)/(8)-1
LOB	% NEP by LOB	Expense Ratio	Risk Factor (Line 4)		IIA (Line 7)		Risk Charge		Change in Risk Chg
			Current	Indicated	Current	Indicated	Current	Indicated	
A-HO	15.8%	0.289	0.936	0.930	0.954	0.966	0.182	0.188	3.0%
B-PPA	24.2%	0.228	0.969	0.970	0.925	0.937	0.125	0.137	10.1%
C-CA	4.1%	0.286	1.010	1.014	0.890	0.903	0.185	0.201	9.1%
D-WC	8.5%	0.262	1.044	1.037	0.839	0.833	0.138	0.126	-8.8%
E-CMP	6.3%	0.356	0.883	0.873	0.896	0.921	0.148	0.160	8.7%
F1-MPL-O	0.4%	0.255	1.668	1.394	0.767	0.795	0.534	0.363	**-32.0%**
F2-MPL-C	1.1%	0.255	1.130	1.146	0.827	0.863	0.189	0.244	**28.8%**
G-SL	0.9%	0.338	0.922	0.894	0.898	0.924	0.166	0.164	-1.1%
H-OL	8.3%	0.304	1.013	0.993	0.816	0.837	0.130	0.135	3.5%
I-SP	7.1%	0.301	0.863	0.795	0.949	0.957	0.120	0.062	**-48.5%**
J-APD	17.4%	0.232	0.836	0.835	0.971	0.979	0.044	0.050	**13.0%**
K-Fid/Sur	1.1%	0.500	0.854	0.657	0.904	0.922	0.272	0.105	**-61.2%**
L-Other	1.7%	0.256	0.935	0.926	0.947	0.958	0.142	0.143	1.2%
M-Intl	0.04%	0.439	1.234	1.476	0.905	0.925	0.556	0.804	**44.7%**
N-Re-Prop	1.4%	0.267	1.170	0.973	0.893	0.919	0.312	0.162	**-48.3%**
O-Re-Liab	1.0%	0.267	1.322	1.183	0.777	0.811	0.295	0.227	**-23.0%**
R-PL	0.5%	0.330	1.263	1.194	0.774	0.801	0.307	0.286	-6.9%
S-FG/MG	0.1%	0.341	1.598	2.431	0.884	0.902	0.754	1.534	**103.5%**
T-Wrnty	0.2%	0.258	0.854	0.985	0.904	0.972	0.030	0.215	**617.5%**
Total/Avg	100.0%	0.270	0.950	0.934	0.915	0.927	0.135	0.133	-1.7%

See notes after Table 1.1B

Table 1.1B
Reserve Risk: Current and Indicated RBC Factors

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)= (8)/(7)-1
LOB	% Reserve by LOB	Risk Factor (Line 4)		IIA (Line 8)		Risk Charge		Change in Risk Chg
		Current	Indicated	Current	Indicated	Current	Indicated	
A-HO	4.6%	0.213	0.226	0.938	0.951	0.138	0.166	20.4%
B-PPA	19.3%	0.179	0.205	0.928	0.937	0.094	0.129	37.2%
C-CA	5.3%	0.276	0.360	0.911	0.926	0.162	0.259	**59.7%**
D-WC	24.5%	0.344	0.382	0.830	0.783	0.116	0.082	**-28.9%**
E-CMP	6.5%	0.494	0.475	0.876	0.898	0.309	0.325	5.1%
F1-MPL-O	1.7%	0.383	0.271	0.865	0.861	0.196	0.094	**-51.9%**
F2-MPL-C	2.7%	0.276	0.172	0.883	0.896	0.127	0.050	**-60.5%**
G-SL	0.8%	0.304	0.401	0.890	0.884	0.161	0.238	**48.5%**
H-OL	19.5%	0.531	0.496	0.852	0.864	0.304	0.293	-3.9%
I-SP	3.6%	0.246	0.272	0.966	0.954	0.204	0.213	4.8%
J-APD	1.2%	0.155	0.137	0.976	0.978	0.127	0.112	-12.0%
K-Fid/Sur	0.7%	0.371	0.586	0.940	0.908	0.289	0.440	**52.4%**
L-Other	1.2%	0.220	0.225	0.967	0.936	0.180	0.147	-18.4%
M-Intl	0.04%	0.359	1.083	0.874	0.889	0.188	0.852	**353.6%**
N-Re-Prop	1.9%	0.415	0.319	0.901	0.913	0.275	0.204	-25.7%
O-Re-Liab	4.3%	0.656	0.596	0.838	0.793	0.388	0.266	**-31.5%**
R-PL	2.4%	0.802	1.377	0.841	0.847	0.515	1.013	**96.6%**
S-FG/MG	0.04%	0.179	0.146	0.926	0.916	0.092	0.050	**-45.8%**
T-Wrnty	0.02%	0.371	0.355	0.940	0.961	0.289	0.302	4.6%
Total/Avg	100.0%	0.365	0.385	0.879	0.872	0.195	0.202	3.5%

See notes on the next page.

Notes to Tables 1.1A and 1.1B

Expense ratio = 2017 average industry expense ratio by LOB.

Premium Risk Charge: Column (8) = (4) * (6) + (3) -1.0; Column (9) = (5) * (7) + (3) -1.0

Reserve Risk Charge: Column (7) = ((1.0+(3)) * (5)) – 1.0; Column (8) = ((1.0+(4)) * (6)) – 1.0

The indicated risk charges reflect the application of a minimum risk charge of 5%. We believe a minimum is appropriate. The current smallest risk charge is approximately 5%. The level of the minimum is a policy matter for the NAIC. The LOBs affected by minimum risk charges and the risk charge before the minimum are S-FG/MG (-5.0%) and F2-MPL-C (-0.9%) for reserve risk and J-APD (4.9%) for premium risk. Negative risk charges arise if the projected future investment income exceeds the 87.5th percentile adverse development or underwriting loss. The average change in reserve risk charge would be +2.6% without the application of the 5% minimum.

The indicated risk charges do not include any transition limitations. In the past, the NAIC limited the maximum change in any LOB risk factor in any year to a set amount. We believe that is a good practice. The maximum change per year is a policy matter for the NAIC.

The risk charges in Table 1.1, columns 8 and 9 for premium risk and 7 and 8 for reserve risk are simplifications. They represent the risk charge for a monoline company with industry average expenses for its LOB, no own-company adjustment (RBC Formula Lines 1-3), no charge for excessive growth, and no loss sensitive business adjustment. The reserve risk charge also does not reflect the reserve discount adjustments or the reinsurance credit risk component that are part of the R4 reserve risk in the RBC Formula. These LOB risk charges are useful in understanding the line-by-line impact of the indicated changes in risk factors and IIAs.

The averages in Table 1.1 are weighted using the 2017 Schedule P Part 1 net earned premium or net loss and loss adjustment expense (LAE) reserves as weights, except that for S-FG/MG, we use S-FG/MG information from RBC Filings because many S-FG/MG companies are not required to make RBC Filings. We show the premium and reserve weights in column 2.

See Terminology (Section 2, first sub-section) and the Glossary at the end of this report for LOB descriptions.

Indicated risk charges are based on the 87.5th percentile safety level used in past Academy Line 4 calibration reports. The safety level is a policy matter for the NAIC.

We show risk charges in columns 8 and 9 for premium and 7 and 8 for reserves, rounded to three decimal places. We calculate the risk charge changes in columns 10 and 9, for premium and reserves, respectively, from the unrounded risk charge values. Because of that rounding, calculating values in those columns from the rounded values may produce values different than those shown.

The “current factors in Table 1.1 differ slightly from the “current factors” in the April 2021 Report, Table 1a, page 7, for two reasons. First, for the LOBs with catastrophe adjustments (see Section 7), the current and indicated factors in Table 1.1A are net of those catastrophe adjustments, while the factors in the April 2021 report are before those adjustments. Second, for all-line averages in this report, the premium and reserve weights for S-FG/MG are from the RBC Filings, as some monoline S-FG/MG companies are not required to make RBC Filings. The weights in the April 2021 Report are from the Annual Statement. The LOB is small but has some large, indicated changes in factors. These two features do not affect the NAIC impact analyses in Tables 1.2 and 1.3.

Table 1.2: NAIC Impact Estimates

To provide a more complete summary of the effect of the revised risk factors by company, NAIC staff applies the 2019 RBC Formula with alternative premium and reserve risk factors and IIAs to each company.[6] The NAIC aggregates and blinds that information and provides it to this Committee.

Table 1.2
Indicated Changes in RBC Values by Type of Company

(1)	(2)	(3)	(4)	(5)	(6)
			% Change in:		
Row	Type of Company	ACL Value with 2019 Risk Charges ($Billions)	Reserve Risk Charge	Premium Risk Charge	ACL
1	Commercial	64.9	4.8%	-4.5%	2.1%
2	Med Prof Liab	2.4	-52.2%	4.8%	-14.3%
3	NOC	0.9	21.3%	-17.6%	1.4%
4	Personal	84.3	12.4%	4.2%	1.6%
5	Reinsurance	8.2	-18.6%	-23.5%	-2.2%
6	Workers Comp	10.1	-9.7%	-2.9%	-4.8%
7	Total	170.6	3.4%	-0.8%	1.0%

Using 2019 RBC Formula with 2022 Line 4 and Line 7/8 factors.
NOC = "Not otherwise classified" Type of Company.[7]

The NAIC calculation includes the own-company adjustment, premium and loss concentration factors, and the interaction of reinsurance credit risk with reserve risk. The NAIC calculations use the company's total expense ratio rather than industry expense ratios by LOB. Therefore, the NAIC impact assessment for R4 and R5 differs from the all-line average for premium and reserve risk we show in Table 1.1.

Table 1.2 shows the composite industry effect on RBC values using Table 1.1 indicated factors, in total and by Type of Company.[8] On this NAIC basis, the change in R4 reserve risk is +3.4% compared to the all-line average of 3.5% from Table 1.1. The change in R5 premium risk is -0.8% compared to the all-line average of -1.7% from Table 1.1.

[6] Including only companies with RBC Filings in 2019 and non-zero net written premium plus loss reserves. The RBC Formula in 2019 has some differences from the current RBC Formula. For example, it does not include the recent change in asset categories and asset risk factors.

[7] "NOC," standing for Not Otherwise Classified, means companies for which the portion of net written premium plus loss reserves is greatest for the sum of the following LOBs: G-SL, K-Fid/Sur, L-Other, M-Intl, or S-FG/MG.

[8] As described in the April 2021 Report, each LOB is categorized as typical of a particular Type of Company, e.g., B-PPA is typical of Personal Lines companies. For each company, the category with the largest amount of net written premium (NWP) + reserves determines the Type for that company. For example, a company with more of its premium in B-PPA, Homeowners A-HO and J-APD than in any of the other groups of LOBs is categorized as Personal. Appendix 8 provides more details.

The Authorized Control Level (ACL), Table 1.2, column 6, reflects the combination of all RBC risk elements.[9] Column 6 shows that the indicated factors and IIAs produce large decreases for the Medical Professional Liability Type of Company. The effect on ACL for other Types of Company is within ±5%. The ACL impact on Reinsurance is low, despite the large decreases in premium risk and reserve risk charges because, on average, reinsurer RBC has a larger than average share of other risks, notably the RBC risk types called R0 and R2.[10,11]

Table 1.3: Distribution of Changes in Risk Charge

Individual companies have distinct characteristics, including distributions of premium and reserves by LOB, so the average risk charge and change in risk charge will not reflect the situation for all companies. To provide a measure of company variability, Table 1.3 shows the distribution of percentage changes in ACL value, comparing the ACL value based on 2022 RBC factors and IIAs to the ACL value based on the indicated risk factors and IIAs.

The change in ACL is within ±5% for about half of the companies and within ±15% for over 75% of companies. It is beyond our scope to review the effects on individual companies, particularly whether the increases move any companies into an RBC action level or decreases move any companies out of an RBC action level.

[9] The indicated risk factors and IIAs in Table 1.1 would be used to calculate the premium and reserve risk charges that become part of the Company Action Level (CAL) RBC. The ACL is 50.0% of the CAL. We describe ACL and CAL further in Section 2, Terminology.

[10] The 2019 RBC Instructions, 8/16/19, page 48, describe R0 and R2 as follows: R0 – Affiliated Insurance Companies and Misc. Other Amounts RBC, and R2 – Equity Assets RBC.

[11] There are a small number of large companies with unusually high proportions of stocks. This can reduce the extent to which the average represents typical companies.

Table 1.3
Distribution of Number of Companies by Change in ACL Values

(1)	(2)	(3)
% Changes in ACL RBC	# companies	% companies
Less Than -50%	9	0%
-50% to -25%	96	5%
-25% to -15%	117	6%
-15% to -5%	194	11%
-5% to 5%	951	52%
5% to 15%	298	16%
15% to 25%	95	5%
25% to 50%	71	4%
Over 50%	6	0%
Total	1,837	100%

2. SUMMARY

In this Report, we assume the reader is familiar with the methods, data, and conclusions presented in the Committee's April 2021 Report.

In this summary, we outline our key calibration methods and assumptions. Tables 2.2-2.4, at the end of this section, show the marginal effect of each method or assumption change. Note that the calculated marginal impacts depend on the order in which we present them in those Tables.

1. Terminology

The Glossary at the end of this Report contains a list of acronyms and key terms. This section presents several of the terms we use routinely.

First, Table 2.1 below shows 19 short-form names for the LOBs used in the RBC Formula. We generally refer to LOBs using the letter and short label combined, i.e., A-HO. The Glossary describes the LOBs in more detail.

Table 2.1
LOB Descriptions

(1)	(2)	(3)		(1)	(2)	(3)
RBC LOB Name (PR017 and PR018)	**Schedule P Letter Code**	**Short Label**		**RBC LOB Name (PR017 and PR018)**	**Schedule P Letter Code**	**Short Label**
H/F	A	HO		AUTO PHYSICAL DAMAGE	J	APD
PPA	B	PPA		FIDELITY/SURETY	K	Fid/Sur
CA	C	CA		OTHER (INCLUDE CREDIT, A&H)	L	Other
WC	D	WC		INTL	M	Intl
CMP	E	CMP		REIN PROPERTY & FINANCIAL LINES	N	Re-Prop
MPL OCCURRENCE	F1	MPL-O		REIN LIABILITY	O	Re-Liab
MPL CLMS MADE	F2	MPL-C		PL	R	PL
SL	G	SL		FINANCIAL/MORTGAGE GUARANTY	S	FG/MG
OL	H	OL		WARRANTY	T	Wrnty
SPECIAL PROPERTY	I	SP				

This Report refers to **risk factors, IIAs,** and **risk charges**.

The **risk factors** are the Line 4 factors in the RBC Formula for both reserve risk (PR017) and premium risk (PR018).

The **IIAs** are the factors on Line 8 (PR017 for reserve risk) or Line 7 (PR018 for premium risks). These measure the extent to which future investment income on assets corresponding to future premium and loss reserves is expected to be available to provide for adverse loss reserve development and/or inadequate premiums. The effect of the IIAs is to reduce the premium and reserve risk charges by the amount of such investment income.[12]

The **risk charge** is the combined effect of the risk factor, the IIA, and, for premium, the expense ratio. The notes in Table 1.1 show the formulas for calculating risk charges by LOB.

When the context is clear, we use the term risk charge to refer to either the percentage risk charge or the dollar amount of the risk charge. When the distinction is significant, we refer to the dollar value as the risk charge value and the percentage as the risk charge %.

[12] In some regulatory capital formulas, e.g., Solvency II, the effect of the future investment income is reflected in discounted loss reserves rather than as a reduction of risk charges.

We use the term **undiscounted risk charge** to mean the risk charge before applying the IIAs, calculated as follows:

> **Undiscounted Premium Risk Charge** $_{LOB}$ = Premium Risk Factor $_{LOB}$ + Industry Average Expense Ratio $_{LOB}$ - 100%
>
> **Undiscounted Reserve Risk Charge** $_{LOB}$ = Reserve Risk Factor $_{LOB}$

We use the term **Present Value (PV) Method** to describe the calibration of risk charges directly rather than calibrating the risk factor and IIA separately.

The term **all-line average**, applied to risk charges, risk factors, etc., means the weighted average of LOB values using the 2017 Schedule P Part 1[13] net earned premium or December 31, 2017, net loss and loss adjustment expense (LAE) reserves.

Interest rates, e.g., 5%, are per annum.

RBC Terminology

Unless otherwise specified, references to the **RBC Formula** and **current factors** relate to the 2022 RBC Formula.

The **Authorized Control Level (ACL)** capital is 50% of the **Company Action Level (CAL)** capital value from the RBC Formula.[14] The factors we discuss are used to produce the CAL level RBC.

R4 and **R5** are the RBC Formula's reserve risk and premium risk elements, respectively.

Age/Development

We use the term "**age**," referring to the development age of losses.

For an Accident Year (AY), age 1 refers to payments, reserves, or incurred amounts as of the end of the AY. The most mature AY data point from Schedule P is at age 10.

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[13] Using RBC values for LOB S-FG/MG, as discussed in Notes to Tables 1.1A and 1.1B.

[14] If the company's Total Adjusted Capital is below the Company Action Level (CAL) value from the RBC Formula, then, according to the RBC Instructions, subject to state laws and regulations, "…the company [is required] to prepare and submit an RBC Plan to the commissioner of their state of domicile. The RBC Plan is to be submitted within 45 days. After review, the commissioner will notify the company if the plan is satisfactory." The value produced by the RBC Formula on PR032, Line 71, is the CAL value.

The Authorized Control Level (ACL) for capital is 50% of the CAL value. "Authorized Control Level authorizes the commissioner to take whatever regulatory actions are considered necessary to protect the best interest of the policyholders and creditors of the insurer, which may include the actions necessary to cause the insurer to be placed under regulatory control (i.e., rehabilitation or liquidation)."

For reserves, the **initial reserve year** is the year ending at the selected valuation date. This is usually the year of the least mature AY in the reserve, i.e., the initial reserve year for the reserves as of December 31, 1995, is 1995.

For reserves, age 1 means the **initial reserve**, i.e., the reserve at the selected valuation date. Age 10 refers to the reserve after nine development years.

2. Interest Rates (Section 3)

The interest rate used in the RBC Formula IIA is 5%, selected in the original RBC calibration in the early 1990s. To our knowledge, there is no written documentation for the 5% interest rate. We understand that the 5% interest rate was selected considering U.S. Treasury interest rates. The U.S. Treasury rates in the early 1990s averaged over 6%.

To choose an updated IIA interest rate for this analysis, we might follow what appears to be the method in the 1990s. As such, we would make a conservative selection considering current interest rates and longer-term trends.

For example, based on 2023 three- and five-year[15] U.S. Treasury interest rates through June 30, 2023, a rate of 4% might be the highest appropriate value.[16] (Table 3.3)

This method would need to be applied carefully. Following the same method for years ending 2018 through 2022 would indicate interest rates ranging from 0.4% to 3.0%. (See Table 3.3). In the current method, the risk charges are sensitive to interest rate changes. Table 2.2, row 5, later in this section, shows that the effect of the change in interest rates from 5% to 4% is an increase in risk charges of 11.3% for premium risk and 17.0% for reserve risk.

The alternative calibration method we use in this Report recognizes that risk factors tend to increase when interest rates increase and vice versa and selects a combined indicated risk charge rather than selecting separate risk factors and IIAs. We call this the present value method, or PV Method. Section 5 explores that method in detail.

When we apply the PV Method, our indicated risk charges are largely independent of interest rate forecasts:

- We use historical interest rates by year to calculate the present values of loss ratios (LRs) and reserve runoff ratios (RRRs)[17] by LOB, company and year.[18]

[15] We show three- and five-year U.S. Treasury interest rates because the durations of those securities reflect the duration of payment patterns for many LOBs.

[16] We use 4% in the interest rate and payment patterns sections of this report to illustrate the effect of a decrease in interest rates in the current method. If we used a lower interest rate, e.g., 3% or 3.5%, with the current method, the indicated risk charges would be larger.

[17] Defined in the April 2021 Report.

[18] As we describe in Section 5, for each LOB, for each year in the 1980-2017 experience period, we use U.S. Treasury interest rates, with durations matching the individual LOB premium or reserve payment patterns. We call these 'duration-matched' interest rates.

- To separate the indicated risk charge into its risk factor and IIA elements, for all LOBs, we use a 4% interest rate, based on current interest rates. The risk charges in the PV Method are not sensitive to the 4% interest rate choice.[19]

3. Payment Patterns (Section 4)

Next, we consider payment pattern data and methods.

3.1: Updated Data

The payment pattern underlying the current IIAs ("2010 Method") was last updated in 2010 using data through 2008. That method uses 10-year payment patterns for most LOBs and up to 15 years for some LOBs. We first update the LOB payment patterns using the same method but with data through 2017. The all-line average effect on risk charges due to the data updated through 2017, with the 5% interest rate, is small, 0.8% for premium risk and 1.3% for reserve risk (Table 2.2, row 3).[20]

3.2: 40-Year Runoff Payment Pattern

For this Report, we use a different method to determine payment patterns. The 2010 Method allows payment patterns to extend up to 15 years. This maximum is realistic for most, but not all, [21] LOBs. Among other features, our revised method allows for payment patterns extending to as many as 40 years of loss payments, as indicated by the data. We refer to the revised method as the "40-year runoff payment pattern" method.

In Section 4, we describe our payment pattern method. Appendix 2, Exhibits A2-5A and A2-5B, show the 40-year runoff payment patterns for premium and reserve risk, respectively.

3.3: Risk Development Horizon & 40-Year Truncated Payment Pattern

Recognizing the potentially long payment patterns for some LOBs highlights that the premium and reserve risk calibration data in this analysis is limited to the 10-year "window" in the Schedule P and RBC data.

Our analysis indicates that risk continues to develop beyond the risk development horizon available in the Schedule P and RBC data. We use the term "reported risk development horizon" or "risk development horizon" to describe the window of available data and the term "risk development horizon adjustment" ("RDHA") to describe how we address the data limitation.

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[19] As we discuss in the sections below, with the PV Method, when interest rates change, risk factors also change in a way that produces the same combined risk charge. From that perspective, a change in interest rate does not affect the risk charge produced by Lines 4 and 7/8. However, for reserve risk, but not for premium risk, for a company with experience that differs from the industry average, calculated with Lines 1-3, the offset is not complete. Higher interest rates make the company experience adjustment somewhat larger and vice versa.

[20] Comparing the risk charges using the indicated risk factors in the April 2021 Report and the current IIAs to risk charges and IIAs in the RBC Formula.,

[21] For payment patterns for premium risk, five LOBs have payments of more than 10% at ages 10 and beyond, D-WC, F1-MPL-O, H-OL, O-Re-Liab, and R-PL.
For reserves, seven LOBs have reserve payments of more than 10% at ages 10 and beyond. The same five LOBs as premium plus G-SL and M-Intl. (Exhibits A3-2A and B).

A complete analysis of the premium and reserve risk beyond year 10 is outside the scope of this Report; however, providing investment income credit for the extended payment periods without considering the full extent of risk development would not be a balanced treatment of risk and financial capacity.

Therefore, we construct LOB payment patterns based on the 40-year runoff payment pattern but limited to 10 years, the AY plus nine years of development, for premium risk and limited to 10 years, the initial reserve year plus nine years of development, for reserve risk. We refer to those as "40-year truncated payment patterns." In using those patterns, we are assuming that the additional risk development is an amount equal to the effect of the difference between the 40-year truncated payment pattern.

Compared to using the IIAs based on the 2010 payment pattern with updated data, the all-line average change in risk charges due to the 40-year truncated payment pattern with a 5% interest rate is +0.3% for premium risk and -8.8% for reserves.[22] (Tables 2.2, row 4)

Appendix 3, Exhibits A3-2A and A3-2B show the 40-year truncated payment patterns for premium and reserve risk, respectively.

4. Present Value (PV) Method (Sections 5 and 6)

All else being equal, we would calibrate risk factors using the longest available period of history and independently establish IIAs based on current or forecasted interest rates and selected payment patterns. However, that is appropriate only to the extent that (a) the history is relevant to the projection of future experience and (b) LRs and RRRs in the history are independent of historical interest rates.

Section 5 examines the relationship between undiscounted risk charges and interest rates. We calculate discounted and undiscounted risk charges on a year-by-year basis from 1980-2017. We observe the following:

- Undiscounted indicated risk charges are correlated with interest rates, higher when interest rates are higher and vice versa.
- There is a downward trend in undiscounted indicated risk charges.[23]
- Discounted risk charges, combining risk factors and interest rates on a year-by-year basis, show a lower correlation with interest rates and a trend closer to zero.

Given the observed correlation and downward trend in risk charges, and given current interest rates, we conclude that separately calibrating risk factors and interest rates would result in

[22] See Section 4 for a discussion of why the 40-year truncated payment pattern for reserves implies a longer payment pattern than the 2010 Method.
[23] This decline over time is closely related to the correlation between declining interest rates and undiscounted risk charges.

inappropriately high risk charges. Therefore, we conclude that calibrating the combined interest rate and risk factor, the PV Method, yields more appropriate risk charges.[24]

In the PV Method, we use year-by-year LRs/RRRs, discounted using the 40-year runoff payment pattern and year-by-year interest rates equal to the rates on U.S. Treasury securities with maturities matching the premium and reserve LOB payment patterns. The indicated risk charges are the 87.5th percentile of these discounted LRs/RRRs over the selected experience period, plus the RDHA, plus, for premium, expenses minus 1.0. [25]

In Section 6, we show the risk charges and changes in risk charges that result from applying the PV Method including the RDHA.

5. Catastrophe adjustments (Section 7)

Beginning with year-end 2017 reporting, the RBC Formula includes a new risk component, R_{CAT}, covering hurricane[26] and earthquake components of the total premium risk. The Line 4 premium risk factors are based on data that includes hurricane and earthquake losses. Therefore, there is a potential duplication between the Line 4 risk factors and R_{CAT}. To remove that duplication, for each affected LOB, beginning with the 2017 RBC Filings, the NAIC reduced the otherwise applicable Line 4 factor by an amount we call the catastrophe adjustment.

This Report contains the first Academy review of the catastrophe adjustment. Regulators provided us with summarized and blinded catastrophe and non-catastrophe data from confidential RBC Filings for this purpose. We evaluate the portion of risk charges related to catastrophes for the years where we have catastrophe data. We evaluate the extent to which those years are representative of the 1988-2017 experience period this Report uses to calibrate risk charges. We produce indicated revised catastrophe adjustments.

Compared to the current catastrophe adjustments, the revised catastrophe adjustments are slightly lower for A-HO and E-CMP, slightly higher for J-APD and O-Re-Liab, moderately higher for I-SP and G-SL, and significantly higher for M-Intl and N-Re-Prop. Higher catastrophe adjustments mean lower Line 4 Factors and vice versa.

Table 7.1 shows the current and indicated catastrophe adjustments by LOB.

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[24] The relationship between interest rate and risk charges is plausible, but it is a matter for future research to examine the extent to which the pattern continues.

[25] The RDHA equals the difference between the risk charges using the 40-year truncated payment pattern and risk charges using the 40-year runoff payment pattern using a 4% interest rate, as shown in Appendix 5, Exhibit A5. The 4% interest rate is the all-line average duration-matched interest rate from 1988 through 2017, the range of our calibration data from Schedule P. This 4% interest rate happens to be the same as the current interest rates that we discuss in Section 3, but we have derived it differently. The RDHA interest rate reflects the interest rate during the 1988-2017 experience period. The interest rate to separate the risk charge into Line 4 and IIA factors is based on current/forecasted interest rates.

[26] Including NAIC-designated tropical storms.

6. WC Tabular Reserve Adjustment (Section 8)

Generally, for Annual Statement purposes, P&C insurance companies report reserves on an undiscounted basis, but there are some exceptions. Most importantly for our analysis, companies are permitted to report D-WC reserves discounted to reflect tabular reserves for lifetime annuity claims (tabular discount).[27] Some companies report WC reserves with tabular discount, and others report on an undiscounted basis. On average, the tabular discount at December 31, 2017, is 3.4% of reported reserves. On average, the LR for 2008, the most mature AY in the 2017 Annual Statement, has a tabular discount equal to 0.6% of premium.

The tabular discount in the data affects the calibration and the application of the RBC Formula. To adjust for this, we calibrate risk charges based on the average company, assuming all companies have the average tabular discount. We increase the D-WC premium risk factor by 0.6% of premium, and we increase the D- WC reserve risk charge by 3.4% of reserves plus 3.4% of the risk charge. Section 8 describes our analysis.

While those adjustments correct the RBC value on average, it remains the case that:

- After the WC tabular adjustment, the risk charge is relatively high for companies that do not discount and relatively low for some companies that do discount, and
- For otherwise identical companies, the RBC Total Adjusted Capital (TAC) for companies that discount will be higher than TAC for companies that do not discount.

Our analysis does not address the lack of comparability.

7. Safety Levels (Section 9)

Following past practice, the indicated risk factors are based on the 87.5th percentile safety level for the RBC CAL.

There have been Working Group discussions about the appropriate safety level to use in various components of the RBC formula. To support potential future discussion about safety levels to use for the reserve and premium risk charges, but not to take a position on the need, if any, for changing the safety level, we compare indicated risk charges using the current safety level of 87.5% to two higher safety levels, 90%, and 95%.[28]

The all-lines average effects on risk charges of using the 90th percentile safety level rather than the 87.5th percentile safety level are increases of 26% and 37% on premium and reserve risk, respectively. The corresponding effects at the 95th percentile safety level are increases of 117% and 175% on premium and reserve risk, respectively (Tables 9.1A and 9.1B, respectively).

Setting the safety level is a policy decision for regulators.

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[27] There may be tabular discounts in other LOBs, for example, for excess WC that is reported in the H-OL LOB. We do not make adjustments on those LOBs.

[28] The safety level is intended to apply to the risk over the time required to fully pay AY losses for premium risk and unpaid losses at the valuation date (runoff time horizon) for reserve risk.

8. Summary of Movements Described Above

This sub-section discusses the all-lines combined movement and the LOB-by-LOB movements in risk charges indicated by our analysis.

All-Lines Combined Movement

Table 2.2 shows the indicated all-line average change in risk charges based on the assumptions and methods used in this Report and outlined in sub-sections 2.1-2.6 above.

Table 2.2
Change in All-Lines Average Indicated Risk Charge with Assumption Changes

(1)		(2)	(3)	(4)		(5)	(6)
Assumptions		Short Label for Tables 2.3 and 2.4	Risk charges			Incremental % Increase in Risk	
			Prem	Rsv		Prem	Rsv
(1)	Current	Current	13.5%	19.5%		0.0%	0.0%
(2)	Ap '21/ Current IIA	Ap '21	13.0%	21.1%		-3.6%	7.7%
(3)	Ap '21/5% Interest; 2010 method updated data	2017 Pay Data	13.1%	21.3%		0.8%	1.3%
(4)	Ap '21/5% Interest; 40-year truncated pay pattern	Trunc 5%	13.2%	19.4%		0.3%	-8.8%
(5)	Ap '21/4% Interest; 40-year truncated	Trunc 4%	14.7%	22.7%		11.3%	17.0%
(6)	PV Approach	PV	13.7%	19.2%		-6.5%	-15.6%
(7)	Revised Cat Adjustments/ WC Tabular Adjustment	Cat/WC	13.3%	20.1%		-3.0%	4.5%
(8)	Total Change (7)/(1)-1.0%	Total	13.3%	20.1%		-1.7%	2.6%

Values in columns 5 and 6 show the percentage change from the prior row to the row with the percentage, e.g., row 3, column 5 shows 0.8% = 13.1 / 13.0-1.0 as %.

Note: We show risk charges in columns 3 and 4, rounded to three decimal places. We calculate the risk charge changes in columns 5 and 6 from the unrounded risk charge values. Because of that rounding, calculating column 5 or 6 from the rounded values in columns 3 and 4 may produce values different than those shown. This rounding effect is particularly noticeable with small changes. For example, in row 3, 0.213 / 0.211 = 0.9%, but 0.21315 / 0.21051 = 1.3%, as shown.
We believe the unrounded percentages better reflect the effect on the RBC values than the rounded values.
This rounding issue applies to all tables in this report.

The 2.6% average increase in reserve risk charges is lower than the 3.5% average increase in reserve risk charges in Table 1.1 because Table 1.1 includes the effect of the 5% minimum risk charge. **We apply the minimum risk charge as a final step, and it is not reflected in any Table in the report other than the Tables in Section 1.**

Columns 3 and 4 show the all-lines average risk charges for premium and reserve risk, respectively. Columns 5 and 6 show the incremental percentage change in risk charge from one set of assumptions to the next. The assumption sets are as follows:

- Row 1: The current all-lines average risk charges.
- Row 2: The risk charges using the indicated risk factors in the April 2021 Report and the current IIAs.

- Rows 3, 4, and 5 show the risk charges with the April 2021 indicated risk factors and IIAs based on each of the following:
  - Row 3: 5% interest, updating the payment pattern data but using the 2010 payment pattern method.
  - Row 4: 5% interest with the 40-year truncated payment pattern.
  - Row 5: 4% interest with the 40-year truncated payment pattern.
- Row 6: "PV"—Risk Charges using the PV Method.
- Row 7: Row 6 with revised catastrophe adjustments and the WC tabular adjustment. Note that catastrophe adjustments apply to premium risk only.

Tables 2.3A and 2.3B below show these incremental movements graphically for premium and reserve risk, respectively. The horizontal labels use the abbreviations from column 2 in Table 2.2.

Table 2.3A
Premium Risk: Movement in Indicated Risk Charge with Assumption Changes Listed in Table 2.2
(Movement as a percentage of risk)

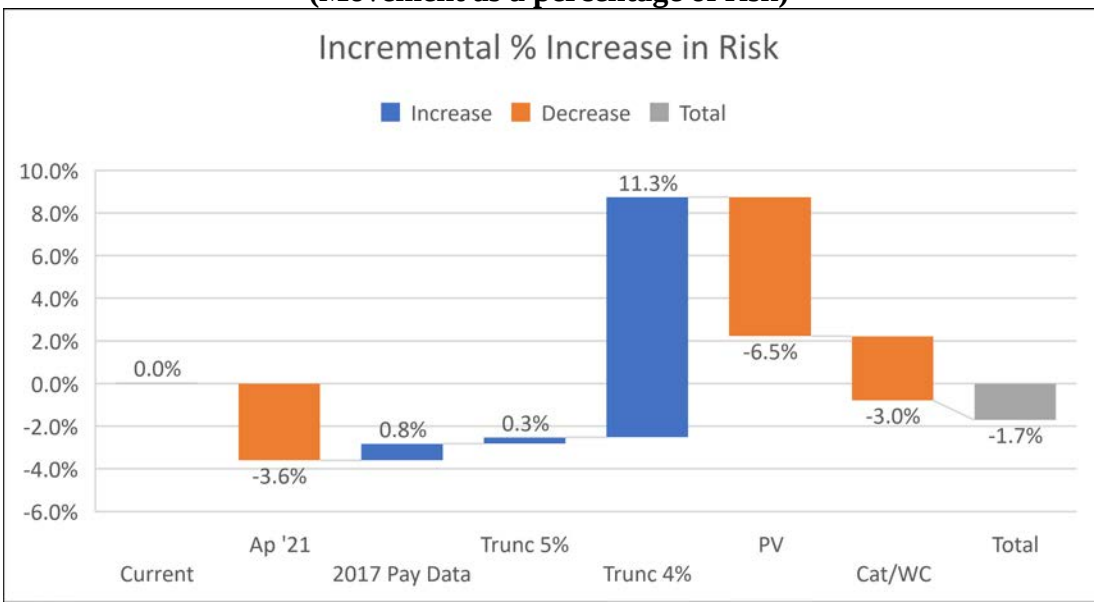
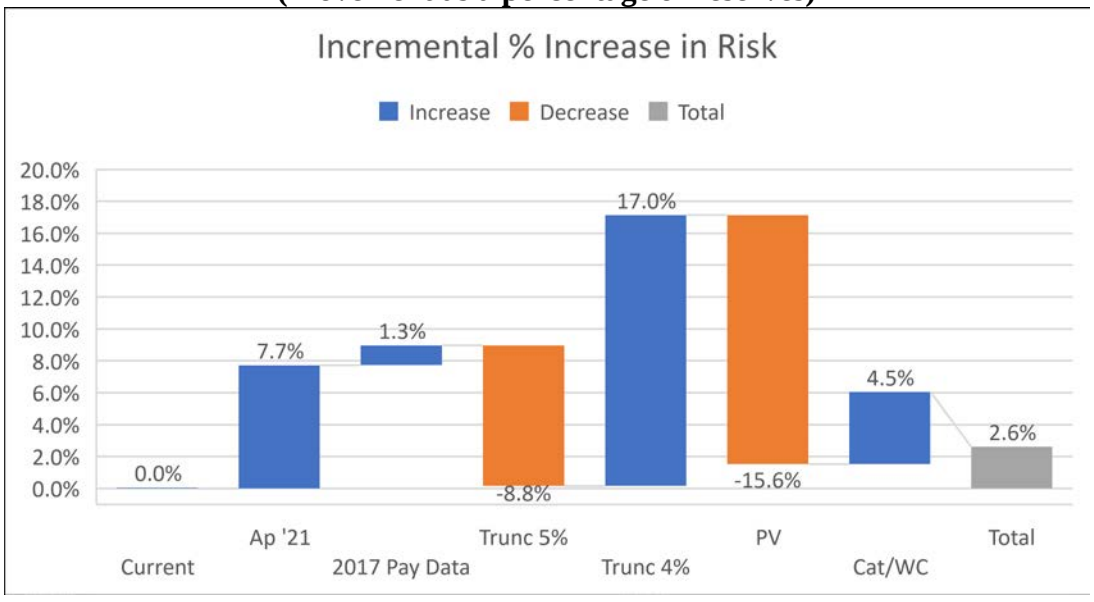


Table 2.3B
Reserve Risk: Movement in Indicated Risk Charge with Assumption Changes Listed in Table 2.2
(Movement as a percentage of reserves)



The all-lines average indicated changes based on the April 2021 analysis, the "Ap '21" bar, are -3.6% for premium risk and +7.7% for reserve risk.

Based on this review, the all-lines average indicated changes are -1.7% for premium risk and +2.6% for reserve risk. Thus, overall, the indicated risk charges from this analysis are for smaller changes (closer to zero) than in the April 2021 review.

However, there are offsetting effects in this analysis. The change to a 4% interest rate would have increased the premium and reserve risk charges. For premium risk, this increase is almost entirely offset using the PV approach and the revised catastrophe adjustment. For reserve risk, the increase due to a change to a 4% interest rate is almost fully offset using the PV Method.

Movement by LOB

Tables 2.4A and 2.4B show the indicated risk charges by LOB with the assumptions listed in Table 2.2.

Column 9 shows the percentage change in the risk charge reflecting all elements of change in indicated risk charges. We list the LOBs from the largest increase to the largest decrease.

Table 2.4A
Premium: Indicated Risk Charges by LOB
According to Movement in Indicated Risk Charge by Analysis Element Shown in Table 2.2
Listed in Order of Decreasing Total Indicated Change

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LOB	Assumption Set							Tot Chg (8)/(2)-100%
	Current	Ap '21	2017 Pay Data	Trunc 5%	Trunc 4%	PV	Cat/WC	
T-Wrnty	3.0%	13.9%	20.2%	20.0%	20.6%	21.6%	21.6%	619.0%
S-FG/MG	75.4%	162.9%	169.5%	162.1%	167.7%	153.4%	153.4%	103.5%
M-Intl	55.6%	98.8%	99.1%	100.4%	103.1%	94.3%	80.4%	44.7%
F2-MPL-C	18.9%	20.5%	21.7%	21.9%	25.2%	24.4%	24.4%	29.0%
J-APD	4.4%	4.5%	4.5%	4.8%	5.2%	5.4%	4.9%	10.6%
B-PPA	12.5%	13.0%	13.0%	12.8%	14.2%	13.7%	13.7%	10.3%
C-CA	18.5%	19.5%	19.3%	18.7%	20.9%	20.1%	20.1%	9.1%
E-CMP	14.8%	14.4%	15.0%	15.3%	16.8%	15.9%	16.1%	9.0%
H-OL	13.0%	13.1%	14.0%	13.0%	16.2%	13.5%	13.5%	3.8%
A-HO	18.2%	17.8%	18.0%	18.2%	18.9%	18.6%	18.8%	3.2%
L-Other	14.2%	14.0%	13.8%	14.1%	15.0%	14.3%	14.3%	1.2%
G-SL	16.6%	17.9%	19.3%	19.2%	20.7%	18.9%	16.4%	-1.4%
R-PL	30.7%	31.3%	32.1%	32.2%	37.0%	28.6%	28.6%	-6.8%
D-WC	13.8%	12.6%	11.9%	12.3%	15.2%	12.0%	12.5%	-9.1%
O-Re-Liab	29.5%	24.0%	26.4%	27.9%	32.0%	23.0%	22.7%	-23.0%
F1-MPL-O	53.4%	39.0%	37.3%	39.1%	45.0%	36.3%	36.3%	-32.1%
N-Re-Prop	31.2%	31.3%	30.6%	32.6%	34.6%	33.5%	16.1%	-48.4%
I-SP	12.0%	7.5%	7.2%	7.3%	8.2%	7.9%	6.2%	-48.4%
K-Fid/Sur	27.2%	10.2%	11.2%	10.3%	11.5%	10.6%	10.6%	-61.0%
Total/Avg	13.5%	13.0%	13.1%	13.2%	14.7%	13.7%	13.3%	-1.7%

Main driving assumptions by LOB for premium risk—Table 2.4A

For each LOB, we highlight the column with the largest absolute change in risk charge (increases or decreases) between columns. For example, the largest increase in T-Wrnty risk charge is from using the April 2021 factors (column 3). The 10.9% increase in risk charge as a percentage of premium, from 3.0% to 13.9%, is larger than any of the other changes between columns for this LOB.

Column 3 shows that six of the eight LOBs with the largest risk charge increases and decreases were identified in the April 2021 report.

Column 6 of Table 2.4A highlights the large number of LOBs where the change in interest rate from 5% to 4% is the largest driver for premium risk. In many cases, however, the increase from column 5 to column 6 is significantly offset by a decrease from column 6 to column 7, as the PV Method offsets a portion of the risk charge increase following from the reduced interest rate.

Column 7 shows that application of the PV Method is the largest driver for three long-tail LOBs: D-WC, O-Re-Liab, and R-PL.

In column 8, we see three LOBs where the largest source of change is the revision to the catastrophe adjustment. These are J-APD, G-SL, and N-Re-Prop.

Table 2.4B
Reserves: Indicated Risk Charges by LOB
According to Movement in Indicated Risk Charge by
Analysis Element Shown in Table 2.2
Listed in Order of Decreasing Total Indicated Change

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LOB	Assumption Set							Tot Chg (8)/(2)-100%
	Current	Ap '21	2017 Pay Data	Trunc 5%	Trunc 4%	PV	Cat/WC	
M-Intl	18.8%	78.7%	90.6%	81.6%	85.7%	85.1%	85.1%	353.5%
R-PL	51.5%	107.9%	104.7%	105.9%	113.1%	101.3%	101.3%	96.6%
C-CA	16.2%	24.0%	24.4%	24.1%	26.3%	25.9%	25.9%	59.5%
K-Fid/Sur	28.9%	50.4%	52.9%	42.5%	45.6%	44.0%	44.0%	52.5%
G-SL	16.1%	25.9%	27.9%	24.5%	27.5%	23.9%	23.9%	48.8%
B-PPA	9.4%	11.5%	11.2%	11.0%	12.7%	12.9%	12.9%	37.6%
A-HO	13.8%	14.7%	15.3%	15.1%	16.4%	16.6%	16.6%	20.4%
E-CMP	30.9%	31.3%	34.2%	32.7%	35.7%	32.5%	32.5%	5.2%
I-SP	20.4%	23.4%	23.5%	20.6%	21.9%	21.3%	21.3%	4.6%
T-Wrnty	28.9%	23.4%	28.1%	24.9%	26.1%	30.2%	30.2%	4.6%
H-OL	30.4%	30.1%	31.3%	29.8%	33.9%	29.2%	29.2%	-4.0%
J-APD	12.7%	10.5%	10.4%	10.2%	10.8%	11.2%	11.2%	-12.1%
L-Other	18.0%	18.5%	18.0%	13.0%	14.7%	14.7%	14.7%	-18.5%
N-Re-Prop	27.5%	21.0%	21.4%	21.2%	23.5%	20.4%	20.4%	-25.7%
D-WC	11.6%	10.8%	10.5%	6.7%	11.3%	4.6%	8.2%	-29.2%
O-Re-Liab	38.8%	37.1%	37.2%	31.3%	36.9%	26.5%	26.5%	-31.6%
F1-MPL-O	19.6%	9.4%	7.6%	6.9%	10.4%	9.4%	9.4%	-52.1%
F2-MPL-C	12.7%	-3.4%	-3.0%	-3.6%	-1.3%	-0.9%	-0.9%	-106.9%
S-FG/MG	9.2%	-7.3%	-4.2%	-10.0%	-8.2%	-5.0%	-5.0%	-154.9%
Total/Avg	19.5%	21.1%	21.3%	19.4%	22.7%	19.2%	20.1%	2.6%

Main driving assumption by LOB for reserve risk—Table 2.4B
Column 3 shows that for 13 of 19 LOBs, the largest increases and decreases were identified in the April 2021 report.

In column 7, we see four LOBs where the PV Method is the largest source of movement. Three of these are the long tail LOBs, D-WC, O-Re-Liab, and H-OL.

9. Calculation of Indicated Risk Factors and IIAs (Section 10)

Section 10 shows how we use indicated risk charges to develop separate indicated Line 4 and Line 7/8 factors.

10. Future Research

Section 11 lists potentially useful future research areas related to underwriting risk.

3. INTEREST RATES

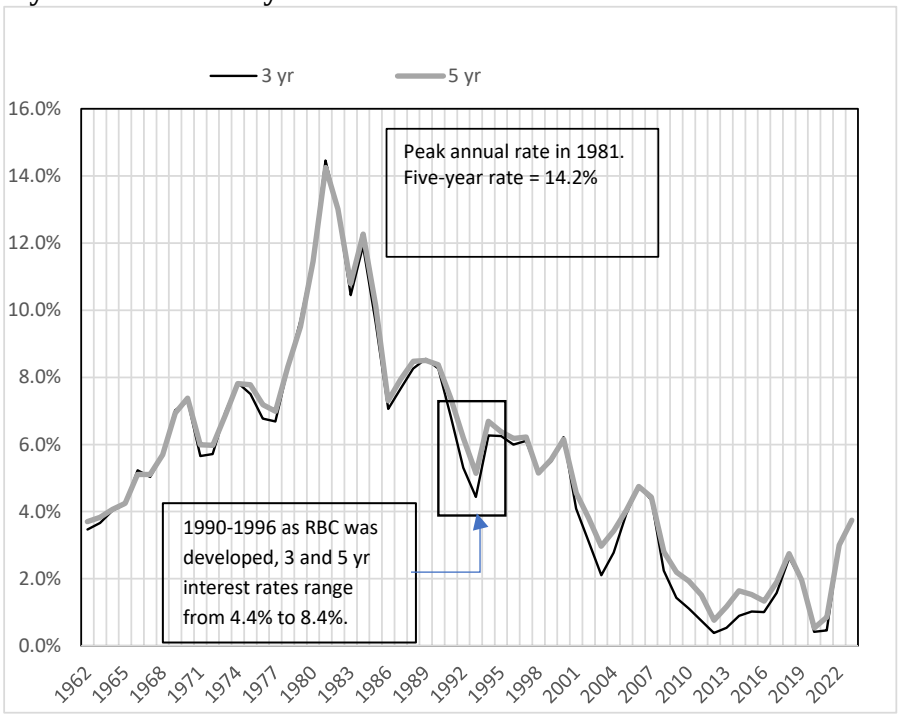
The IIAs measure the extent to which future investment income on assets corresponding to future premium and loss reserves is expected to be available to provide for adverse loss reserve development and/or inadequate premiums. The effect of the IIAs is to reduce the premium and reserve risk charges by the amount of such investment income.

The IIAs depend on selected interest rates, which we discuss in this section, and payment patterns, which we discuss in the next section.

History of U.S. Treasury Rates

Table 3.1 below shows three- and five-year U.S. Treasury interest rates since 1962. We show those durations as those reflect the duration of payment patterns for many LOBs.

Table 3.1
History of U.S. Treasury Interest Rates—Three- and Five-Year Maturities



Notes: Data through June 30, 2023.
Annual averages of daily interest rates at constant maturity from Federal Reserve History.[29]
In the 1990-1996 period, the 4.4% minimum interest rate is the 1993 three-year rate, and the 8.4% maximum interest rate is the 1990 five-year rate.

In Table 3.1, we see the following:

- Interest rates increased from 3-4% in 1962 to 14-15% in 1981 and then generally declined from that high point, and
- Within that pattern, there are smaller but still significant variations.

Indicated Interest Rates

The interest rate used in the current RBC Formula IIA is 5%, selected in the original RBC calibration in the early 1990s. To our knowledge, there is no written documentation for the 5% interest rate. We understand that the 5% interest rate was selected considering U.S. Treasury

[29] Board Of Governors of The Federal Reserve System, "Data Download Program."

interest rates. The U.S. Treasury rates in the early 1990s averaged over 6%[30,31] as summarized in Table 3.2 below.

Table 3.2
U.S. Treasury Interest Rates
Average Annual Interest Rates: 1990-1996

	1990-1996	
	3 Year	5 Year
Max	8.3%	8.4%
Min	4.4%	5.1%
Average	6.2%	6.6%

Maximum interest rates were in 1990,
Minimum interest rates were in 1993.

Table 3.3 below shows the average annual interest rates for 2018-2022 and 2023 through June 30, 2023. Table 3.4 shows the monthly average interest rates in 2023. Table 3.5 shows some longer-term interest rate averages.

Table 3.3
U.S. Treasury Interest Rates—Annual

A. Date Range	3 Year	5 Year
2018	2.6%	2.7%
2019	1.9%	2.0%
2020	0.4%	0.5%
2021	0.5%	0.9%
2022	3.0%	3.0%
Jan - June 2023	4.0%	3.7%

[30] Feldblum notes that 5% was selected, and he contrasts the 5% NAIC selection to the then current IRS Federal Income Tax methodology that used a moving average of Federal Midterm Rates, which have remaining terms of 3-9 years. Feldblum, Sholom, "NAIC Property/Casualty Risk-Based Capital Requirements," *Proceedings of the Casualty Actuarial Society*, 1996, pp. 297-435.

[31] In one earlier contemporaneous source, Allan Kaufman and Elise C. Liebers, in "NAIC Risk Based Capital Efforts in 1990-91," Insurer Financial Solvency, Casualty Actuarial Society Insurer solvency Discussion Paper Program, 1992, Vol I, pp. 123–178, observed the following about the investment income treatment in RBC UW risk (page 149), *Before applying this [*risk charge*] percentage to the company's held undiscounted reserves, adjustments are made to reflect each company's historical experience in establishing adequate reserves.* ***The percentage is further modified to reflect a conservative estimate of investment income*** [emphasis added]**.**

And, Pages 160-161 read:

For both reserve and pricing risk purposes the RBC Draft uses the mid-1980's loss experience in combination with a 5% interest rate. Since the actual mid-1980's interest rates exceeded l0%, the process might be viewed as assuming a 1980's loss and LAE ratio and reserve deficiency at a time when interest rates are only 5%. ***The combined effect might be viewed as a high standard for RBC.*** *[emphasis added]*

Table 3.4
U.S. Treasury Interest Rates—2023 Monthly

B. Monthly 2023	3 Year	5 Year
Jan-23	3.9%	3.6%
Feb-23	4.2%	3.9%
Mar-23	4.1%	3.8%
Apr-23	3.8%	3.5%
May-23	3.8%	3.6%
Jun-23	4.3%	3.9%

Table 3.5
U.S. Treasury Interest Rates—Longer-Term Averages

C. Other Time Periods	3 Year	5 Year
Avg 1988-2017	4.0%	4.4%
Avg 2017-2019	2.0%	2.2%
Annualized Daily Max since 2010	4.7%	4.5%
Annualized Daily Min since 2010	0.1%	0.2%
Average since 2010	1.3%	1.7%

To choose the updated IIA interest rate for this analysis, we might follow what appears to be the method used in the 1990s. As such, we would make a conservative selection considering current interest rates and longer-term trends, e.g., Table 3.5. The results of the method are not stable, as follows:

- Looking at 2023 through June 30, from Table 3.3, a rate of 4% might be the highest appropriate interest rate for IIAs. However, if we had followed the same method at years ended 2018 through 2022, we would have indicated interest rates ranging from 0.5% to 3%.
- A longer-term view, looking at 1988-2017, would indicate that an interest rate of 4% might be the highest appropriate value, but a more recent post-financial crisis/pre-pandemic view based on 2017-2019 might support a 2% interest rate.
- The difference in all-line average risk charges between a 4% interest rate and a 2% interest rate is over 20% for premium risk and nearly 30% for reserve risk.[32]

Given the variability, applying this method and avoiding undesirable and unnecessary interest rate changes over short time frames would be challenging.

[32] Based on current Line 4 factors and the 2010 payment pattern method updated with 2017 data, discussed in Section 4.

An alternative calibration method we use in this Report recognizes that risk factors tend to increase when interest rates increase and vice versa and selects a combined indicated risk charge rather than selecting separate risk factors and IIAs. Section 5 explores that method in detail.

When we apply the alternative method, our indicated risk charges are largely independent of interest rate forecasts:

- We use historical interest rates by year to calculate the present values of LRs and RRRs by company, year, and LOB.
- To separate the indicated risk charges into its risk factor and IIA elements, for all LOBs, we use a 4% interest rate to separate the risk factor and IIA elements of the indicated risk charge. The risk charges are not sensitive to the 4% interest rate choice.[33]

Use of U.S. Treasury Interest Rates

Insurance companies invest in a variety of asset types. Table 3.6, below, shows the industry total asset distribution from 2021 RBC Filings.

[33] See footnote 19.

Table 3.6
Distribution of Assets by Rating Class
Industry Total from RBC Filings at December 31, 2021

(1)	(2)	(3)	(4)	(5)
NAIC Designation	Rating	2021 $ Billions	% Bonds	Cum % Reserves
U.S. Gov't	Risk Free	258.2	20.6%	34%
1.A, Other	AAA	274.2	21.9%	70%
1.B	AA+	64.6	5.2%	78%
1.C	AA	78.2	6.2%	88%
1.D	AA-	68.3	5.5%	97%
1.E	A+	54.1	4.3%	104%
1.F	A	97.2	7.8%	117%
1.G	A-	73.1	5.8%	127%
2	BBB	218.8	17.5%	155%
3	BB	34.2	2.7%	160%
4	B	26.5	2.1%	163%
5	CCC	4.8	0.4%	164%
6	CC,C,D	0.9	0.1%	164%
Total		1,253.1	100.0%	
Carried Loss and LAE Reserves- RBC Filings				764.1

2021 assets are total of long-term (Schedule D), short-term (Schedule DA), and cash equivalents (Schedule E) from RBC Filings. Long term Schedule D bonds are $161.4 billion of the total $258.2 billion in the U.S. Government category above.

At December 31, 1998, RBC Filings show Schedule D U.S. Gov't bonds were 43% of loss and LAE reserves ($144.9 billion compared to $339.9 billion), compared to 21% of loss and LAE reserves in 2021 ($161.4 billion compared to $764.1 billion).[34]

Our calibration uses U.S. Treasury rates for reasons including the following:

- Using U.S. Treasury interest rates is consistent with our understanding of the original calibration.
- U.S. Treasury securities and closely related low-risk assets are a core P&C insurance industry asset category. Table 3.6 above shows that in 2021, U.S. Government securities constitute 34% of the P&C industry loss and LAE reserve amount, and those plus AAA securities constitute 70% of the P&C industry loss and LAE reserve amount.

[34] RBC had more asset detail in 2021 than in 1998, so the comparison is limited to long-term U.S. Treasury bonds (reported on Schedule D).

- We use 1988-2017 U.S. Treasury interest rates to discount the LRs and RRRs by year. The mix of insurance company assets in that period was even more heavily weighted towards U.S. Treasuries than is currently the case.
- To the extent that companies invest in a variety of assets, the lowest-risk securities can be viewed as supporting reserves plus the portion of capital equal to the required RBC value.
- The IRS used U.S. Treasuries for tax purposes in the past. The tax law now uses interest rates based on a corporate bond yield curve.[35] We understand that this index is calibrated to a "…market-weighted average (MWA) quality of the AAA, AA, and A bonds used to compute it."[36] The bonds in the 2010 tax law calibration are 77% A, 16% AA, and 6% AAA,[37] i.e., heavily weighted to bonds with A rating. P&C insurer bond assets with a rating of AA and higher make up 88% of the loss and LAE reserve amount. Hence the corporate bond index rate is not consistent with P&C insurer portfolios, particularly given our objective of matching the safest assets with the reserves and RBC amounts.
- Companies with capital near the RBC Action Levels might tend to hold higher-rated securities than the average company.

4. PAYMENT PATTERNS

2010 and Revised Methods

The LOB payment patterns used to calculate the IIAs in the RBC Formula were last calibrated in 2010 ("2010 Method") using 2008 data. We describe this method in Appendix 1.

For this Report, we use a different method, which, among other features, allows for up to 40 years of loss payments, although nearly all LOBs have much shorter patterns. We refer to this method as the 40-year runoff payment pattern. We describe this method in Appendix 2.

The main differences between the two methods and our reasons for choosing the revised method are the following:

[35] "Specifically, the new interest rates will be based on corporate bonds with varying maturities for the preceding 60-months that are in the top 3 quality levels available." In Arlene M. Richardson, FCAS, MAAA, and Joel S. Chansky, FCAS, MAAA, "Federal Income Taxes—Provisions Affecting Property and Casualty Insurers: An Update to the Almagro/Ghezzi Paper of 1988 and the Feldblum Paper Of 2007," Casualty Actuarial Society, 2021, p25.

[36] James A. Girola, "Introduction to the HQM [High Quality Market] Yield Curve," PowerPoint presentation, U.S. Department of the Treasury, April 12, 2010, p9.

[37] Ibid., p44.

For AY Patterns

1. The 2010 Method uses data solely from Schedule P Part 1, which contains payment data at a single point in time. Therefore, the payment pattern for ages 1-10 is based cumulative paid loss and LAE at that point in time. As such, there may be random year-to-year variations, especially for smaller LOBs and LOBs subject to catastrophe events that are not uniformly distributed by AY.

   The revised method uses Schedule P Part 3, which contains payment data at up to 10 calendar year-ends. As such, the revised method's payment pattern is based on the average of multiple calendar years of payments, and it is less subject to undesirable variability and more likely to represent the expected future payment pattern.

2. In the 2010 Method, the loss and LAE paid each year after age 10 is assumed to be paid at a uniform percentage of expected ultimate payments.

   In the revised method, we assume that the unpaid at age 10 is paid at a rate that declines exponentially over time.

   In our experience, a declining percentage payment rate by year is more realistic than a uniform percentage payment rate by year.

3. In the 2010 Method, payment percentages for ages 11 and over require subjective judgments when AY payment percentages are negative, e.g., subrogation, or do not decline monotonically, or have particularly large unpaid percentages at age 10, e.g., D-WC.

   Those features do not distort the revised method.

Reserve Payment Patterns

4. Reserve year patterns are derived from the AY payment patterns. In addition, they depend on the treatment of reserves for AYs at ages 10 and over, called "prior" in Schedule P.

   The 2010 Method does not use prior year reserves in its payment pattern or discounting calculations. That feature has the effect of assuming that the discount factor for prior year reserves equals the average of the discount factors for reserves for AYs with ages 1-10, or up to 15 for certain LOBs. Actually, the discount factor for prior year reserves should be lower (more discount) since reserves for more developed AYs that make up the prior year reserve tend to be paid more slowly than those for less developed AYs.

   The revised method uses the prior year reserves and explicitly models the payments for AYs at ages 10 and over. These differences imply a longer reserve payment pattern than the 2010 Method.

5. In the 2010 Method, for those LOBs for which Schedule P contains information on only the most recent two AYs (Two-Year LOBs), only two years of paid development data are available.

In the revised method, we use 10 years of paid development data for Two-Year LOBs[38] from the RBC Filings to produce a more realistic estimate of payments beyond age two. This has a greater effect on reserve payment patterns than on premium payment patterns.

One weakness of the revised method compared to the 2010 Method is that the revised method assumes the payment pattern for Adjusting and Other Expenses (A&O) is the same as the payment pattern for losses, A&O, and Defense and Cost Containment Expense (DCCE). The 2010 Method assumes adjusting and other payments are made at the rate they are recorded in the Annual Statement.

RDHA & 40-Year Truncated Payment Pattern

While LOB payment patterns can extend for decades, the premium and reserve risk calibration data in this analysis is limited to 10 years because that is the limit on development shown in Schedule P. Our analysis in Appendix 3, Exhibit A3-1 indicates that risk continues to develop beyond the risk development horizon available to us in the Schedule P and RBC data.

A complete analysis of the premium and reserve risk beyond age ten is outside the scope of this Report; however, providing investment income credit for the extended payment periods without considering the full extent of risk development would not be a balanced treatment of risk and financial capacity.

Therefore, we construct LOB payment patterns based on the 40-year runoff payment pattern but limited to 10 years, the AY plus nine years of development, for premium risk and limited to 10 years, the initial reserve year plus nine years of development, for reserve risk. We refer to those as "40-year truncated payment patterns." In using those patterns, we are assuming that the additional risk development is an amount equal to the effect of the difference between the 40-year truncated payment pattern and the 40-year runoff payment pattern.

The advantages of this RDHA method include the following:

- The method explicitly recognizes that payment patterns and risk development extend longer than Schedule P data.
- The RDHAs are larger for longer tail LOBs, as should be generally expected.
- The RDHA is qualitatively correct in that the degree of risk development will depend on the timing of loss payments over time.
- The method maintains the "status quo" of truncated payment patterns and risk development largely limited to Schedule P's ten years of data.

Appendix 3, Exhibits A3-2A and 2B show the premium and reserve 40-year truncated payment patterns, respectively.

[38] Except for T-Wrnty, where RBC data at 2017 is not sufficiently reliable. The revised method uses Schedule P Part 2 and Part 3 data for T-Wrnty.

Effect of Updated Data, Revised Method, and Change in Interest Rates

This section discusses the all-line average and line-by-line effects of the updated data and revised method. Appendix 4 provides further details.

All-Lines Average Effect

Tables 4.1A and 4.1B below show the all-lines average premium and reserve IIAs and indicated risk charges with three payment pattern scenarios: the 2022 RBC Formula (i.e., based on the 2010 Method using 2008 data), the 2010 payment pattern method with 2017 data, and the 40-year truncated payment pattern. We consider the last of these at the current 5% interest rate in the RBC Formula and the 4% interest rate based on recent experience.

Table 4.1A
Premium: Effect on Risk Charges of Revised Payment Pattern Methods and Interest Rates

Row	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Payment Pattern Method	Interest Rate	Short Label for Table 4.2	IIA	Risk Chg	% Change vs Prior Row	
						% Risk	% Prem
1	2022 IIA	5.0%	Current	0.915	13.5%	base	base
2	2010 method/2017 data	5.0%	2017 Pay Data	0.916	13.6%	0.8%	0.1%
3	40--Year/Trucated	5.0%	Trunc 5%	0.917	13.7%	0.3%	0.0%
4	40--Year/Trucated	4.0%	Trunc 4%	0.932	15.2%	10.9%	1.5%
5	Indicated vs. 2022				15.2%	12.1%	1.6%

Risk charges using Line 4 Factors from the 2022 RBC Formula. Values in columns 6 and 7 show the percentage change from the prior row to the current row in column 5. We use the unrounded values underlying column 5 to calculate columns 6 and 7, so using rounded values in column 5 might not always reproduce columns 6 and 7. Rounding differences are particularly noticeable with small changes. For example, column 6, row 3, shows 0.3%. This is based on 0.136606 / 0.136195, the unrounded column 5 values. Looking at the rounded values in column 5, we see .137 / .136-1.0 = 0.7% rather than 0.3%.
The value shown, based on the unrounded column 5, better represents the impact on RBC.

The values in column 5 differ from the corresponding values in Table 2.2. Table 2.2 is based on April 2021 indicated Line 4 factors, while this Table is based on the Line 4 factors in the 2022 RBC Formula.

Table 4.1B
Reserves: Effect on Risk Charges of Revised Payment Pattern Methods and Interest Rates

Row	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Payment Pattern Method	Interest Rate	Short Label for Table 4.2	IIA	Risk Chg	% Change vs Prior Row	
						% Risk	% Rsv
1	2022 IIA	5.0%	Current	0.879	19.5%	base	base
2	2010 method/2017 data	5.0%	2017 Pay Data	0.881	19.8%	1.4%	0.3%
3	40--Year/Trucated	5.0%	Trunc 5%	0.867	17.9%	-9.5%	-1.9%
4	40--Year/Trucated	4.0%	Trunc 4%	0.890	21.2%	18.2%	3.3%
5	Indicated vs. 2022				21.2%	8.5%	1.7%

See notes to Table 4.1A.

We observe the following about the all-lines average risk charges:

- Both Premium and Reserve Risk

Row 2 vs. Row 1: IIAs from the 2010 Method with 2017 data are not materially different from the current IIAs, i.e., row 2 shows that the effects on risk charges are only 0.8% and 1.4% for premium and reserve risk, respectively.

Row 4 vs. Row 3: A 100 basis point change in interest rate, from 5% to 4%, significantly affects the all-lines average risk charges, +10.9% and 18.2% for premium and reserve risk, respectively.

- Premium Risk: Table 4.1A—Rows 2 and 3

Using the 40-year truncated payment pattern does not materially affect the all-lines premium risk charge, compared to the current risk charge, +0.3% (column 6, row 3).

- Reserve Risk: Table 4.1B—Rows 2 and 3

The reserve risk charge with the 40-truncated payment pattern is lower than the risk charge with IIAs based on the 2010 Method with 2017 data, -9.5%[39] (column 6, row 3).

Effect by LOB

Tables 4.2A and 4.2B below show the percentage change in risk charge, corresponding to Table 4.1 for each of the payment pattern/interest rate combinations in Table 4.1 for each LOB.

We list the LOBs from largest increase to largest decrease as a percentage of risk charge. Appendix 4 shows the indicated IIAs and risk charges underlying these Tables.

For each LOB, we highlight the column with the largest absolute change in risk charge (increases or decreases) between columns.

[39] The 40-year truncated payment pattern is longer (implying more investment income and lower risk charges) than the 2010 Method for reserve risk for reasons that include the following: (a) the differences in the treatment of the prior year reserves and (b) the use of 10-year payment pattern data for Two-Year LOBs in the 40-year payment pattern methods.

Table 4.2A
Premium: Indicated Risk Charge by LOB
Listed in Order of Decreasing Indicated Change—Column 6
According to Movement in Indicated Risk Charge by Analysis Element Listed in Table 4.1

(1)	(2)	(3)	(4)	(5)	(6)	(7)
LOB	Premium Risk Charges				Change in Risk Charge	
	Current	2017 Pay Data	Trunc 5%	Trunc 4%	% Risk (5)/(2)-100%	% Premium (5)-(2)
T-Wrnty	3.0%	8.5%	8.3%	8.9%	194.8%	5.8%
O-Re-Liab	29.5%	31.9%	33.5%	37.9%	28.5%	8.4%
F2-MPL-C	18.9%	20.0%	20.3%	23.5%	24.3%	4.6%
H-OL	13.0%	13.9%	12.9%	16.2%	24.0%	3.1%
D-WC	13.8%	13.1%	13.5%	16.4%	19.3%	2.7%
R-PL	30.7%	31.5%	31.7%	36.4%	18.5%	5.7%
G-SL	16.6%	18.0%	17.9%	19.4%	16.5%	2.7%
E-CMP	14.8%	15.3%	15.7%	17.2%	16.4%	2.4%
J-APD	4.4%	4.4%	4.7%	5.1%	16.1%	0.7%
F1-MPL-O	53.4%	51.5%	53.5%	60.2%	12.7%	6.8%
N-Re-Prop	31.2%	30.5%	32.6%	34.6%	10.8%	3.4%
B-PPA	12.5%	12.4%	12.3%	13.6%	9.4%	1.2%
C-CA	18.5%	18.2%	17.7%	19.8%	7.4%	1.4%
L-Other	14.2%	13.9%	14.3%	15.2%	7.4%	1.0%
K-Fid/Sur	27.2%	28.5%	27.4%	28.8%	6.1%	1.7%
A-HO	18.2%	18.4%	18.6%	19.3%	6.1%	1.1%
I-SP	12.0%	11.7%	11.9%	12.7%	6.0%	0.7%
M-Intl	55.6%	55.8%	56.7%	58.7%	5.5%	3.1%
S-FG/MG	75.4%	79.5%	74.9%	78.3%	3.9%	2.9%
Avg	13.5%	13.6%	13.7%	15.2%	12.1%	1.6%

Risk charges in columns (2)-(5) use Line 4 factors from the 2022 RBC Formula.
The average row equals the corresponding values in Table 4.1A

For premium risk, generally, the change in interest rate from 5% to 4%, column 5, produces the largest change from column to column.

For T-Wrnty, this would be the first change in risk charges based on T-Wrnty experience. In the RBC Formula, T-Wrnty IIAs are set equal to IIAs for K-Fid/Sur, which contained T-Wrnty business before 2008. Experience shows that the T-Wrnty payment pattern is much shorter than the K-Fid/Sur payment pattern.

Table 4.2B
Reserves: Indicated Risk Charge by LOB
Listed in Order of Decreasing Indicated Change—Column 6
According to Movement in Indicated Risk Charge by Analysis Element Listed in Table 4.1

(1)	(2)	(3)	(4)	(5)	(6)	(7)
LOB	Reserve Risk Charges				Change in Risk Charge	
	Current	2017 Pay Data	Trunc 5%	Trunc 4%	% Risk (5)/(2)-100%	% Reserve (5)-(2)
M-Intl	18.8%	26.7%	20.7%	23.4%	24.7%	4.6%
F2-MPL-C	12.7%	13.2%	12.5%	15.2%	19.7%	2.5%
E-CMP	30.9%	33.7%	32.2%	35.3%	14.2%	4.4%
C-CA	16.2%	16.6%	16.3%	18.4%	13.3%	2.2%
A-HO	13.8%	14.4%	14.2%	15.5%	12.5%	1.7%
B-PPA	9.4%	9.1%	8.9%	10.6%	12.4%	1.2%
H-OL	30.4%	31.6%	30.2%	34.2%	12.3%	3.8%
T-Wrnty	28.9%	33.8%	30.5%	31.8%	10.0%	2.9%
N-Re-Prop	27.5%	27.9%	27.6%	30.1%	9.5%	2.6%
G-SL	16.1%	17.9%	14.8%	17.5%	9.2%	1.5%
R-PL	51.5%	49.2%	50.1%	55.3%	7.4%	3.8%
F1-MPL-O	19.6%	17.6%	16.9%	20.6%	5.1%	1.0%
D-WC	11.6%	11.2%	7.4%	12.0%	4.2%	0.5%
J-APD	12.7%	12.6%	12.4%	13.0%	2.1%	0.3%
O-Re-Liab	38.8%	38.9%	32.9%	38.5%	-0.6%	-0.2%
I-SP	20.4%	20.4%	17.6%	18.9%	-7.3%	-1.5%
S-FG/MG	9.2%	12.9%	6.0%	8.2%	-11.1%	-1.0%
K-Fid/Sur	28.9%	31.0%	22.1%	24.8%	-14.2%	-4.1%
L-Other	18.0%	17.5%	12.5%	14.3%	-20.7%	-3.7%
Avg	19.5%	19.8%	17.9%	21.2%	8.5%	1.7%

Risk charges in columns (2)-(5) use Line 4 factors from the 2022 RBC Formula.
The average row equals the corresponding values in Table 4.1B

For reserve risk, the change in interest rate from 5% to 4%, column 5, often produces the largest change, from column to column.

The change from the 2010 method to the 40-year truncated payment patterns, column 4, is also important. For the Two-Year LOBs, the 40-year truncated method uses the RBC payment pattern information and therefore recognizes that the payment patterns extend beyond two years.[40] The 2010 method uses Annual Statement data and therefore has a shorter payment pattern for those LOBs. We see this effect for Two-Year LOBs I-SP, S-FG/MG, K-Fid/Sur, and L-Other.

[40] Except for T-Wrnty, where RBC data at 2017 is not sufficiently reliable. The revised method uses Schedule P Part 2 and Part 3 data for T-Wrnty.

5. RISK FACTORS AND INTEREST RATES—PV METHOD

All else being equal, we would calibrate risk factors using the longest available period of history and independently establish IIAs based on current or forecasted interest rates and selected payment patterns. However, that is appropriate only to the extent that (a) the history is relevant to the projection of future experience and (b) LRs and RRRs in the history are independent of historical interest rates.

This section examines the variation in experience over time.

We find that movements in risk charges by LOB over time are volatile. To understand the large-scale patterns more readily, we construct indices representing the multi-line average indicated undiscounted risk charge by year for the eight (premium risk) or seven (reserve risk) LOBs with experience from 1980 to the present.[41]

Tables 5.1A and 5.1B show the year-by-year average of the indicated undiscounted premium and reserve risk charges, respectively.

[41] The LOBs included in the index are A-HO, B-PPA, C-CA, D-WC, E-CMP, G-SL and H-OL for both premium risk and reserve risk, plus O-Re-Liab for premium risk. For O-Re-Liab, for premium risk, data for AYs 2014-2017 is removed by the maturity filter, but for purposes of this index, we extrapolate O-Re-Liab LRs for 2014-2017 using H-OL experience in 2014-2017 and the relationship between H-OL and O-Re-Liab for AYs 2008-2013.

The LOBs in these indices constitute 69% of all-lines 2017 premium and 80% of all-lines 2017 reserves.

Table 5.1A
Premium—Indicated Undiscounted Risk Charge by Year (Eight LOBs)

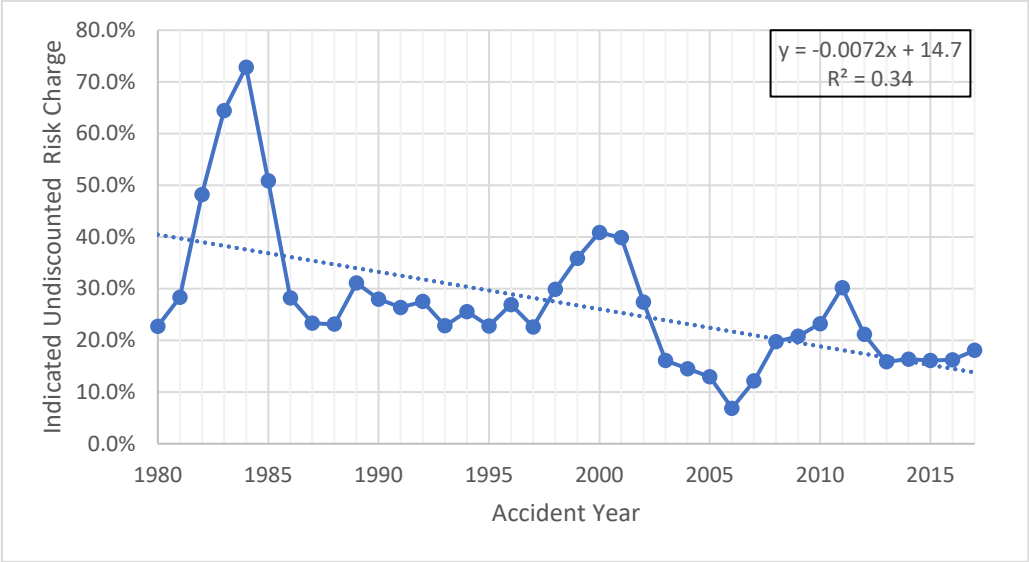


Table 5.1B
Reserves: Indicated Undiscounted Risk Charge by Year (Seven LOBs)

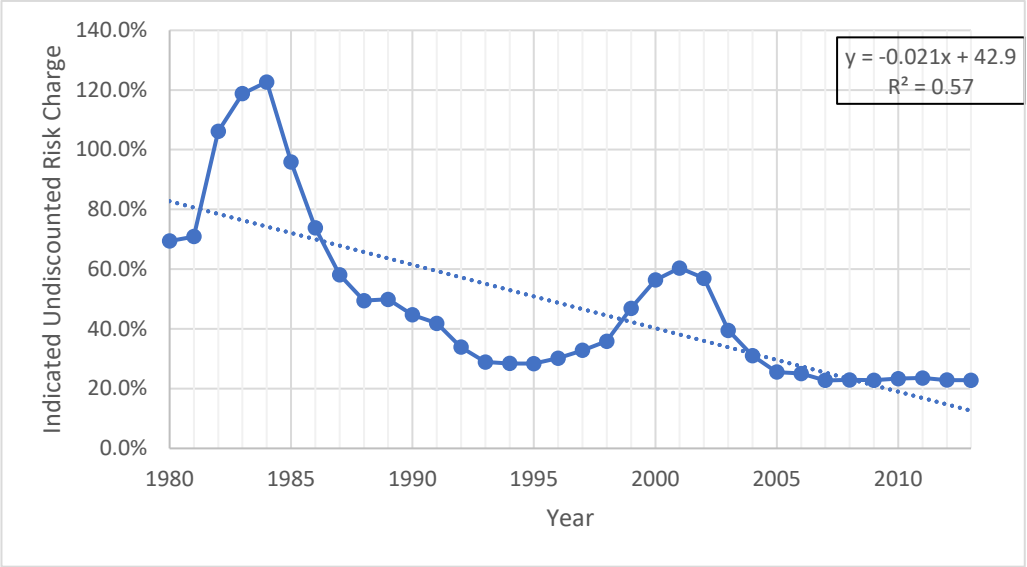


Table 5.1A shows the following for premium risk:

- The year-by-year eight-line average indicated undiscounted risk charge varies widely, ranging from over 70% to under 10%;
- A long-term downward trend, 0.72% of premium per year, with an R-squared value of 34%; and

- There are local maximum values, i.e., values above the trend line, in 1982-1985, 1998-2002, and again in 2009-2012.

Similarly, Table 5.1B shows the following for reserve risk:

- The year-by-year seven-line average indicated undiscounted risk charge varies widely, ranging from over 120% to about 20%;
- A long-term downward trend, 2.1% of reserve per year, with an R-squared value of 57%; and
- There are local maximum values, i.e., values above the trend line, in 1982-1986, 1999-2003, and again in 2010-2013.

Interest Rates and Risk Charges

Section 3 shows that interest rates have declined in recent decades. Therefore, we consider the extent, if at all, to which indicated undiscounted risk charges and interest rates are related.

Tables 5.2A and 5.2B show interest rates and indicated undiscounted risk charges over time. For each LOB, the interest rates are the historical U.S. Treasury interest rates, with durations matched to the LOB payment pattern.[42] The interest rate for the eight/seven multi-line composite is the premium or reserve-weighted average of the separate LOB interest rates. The indicated undiscounted risk charges are the values in Tables 5.1A and 5.1B for premium and reserve risk, respectively.

The horizontal axis shows the AYs and initial reserve years. The left vertical axis shows the indicated undiscounted premium/reserve risk charges. The right vertical axis shows the duration-matched U.S. Treasury interest rate described above.

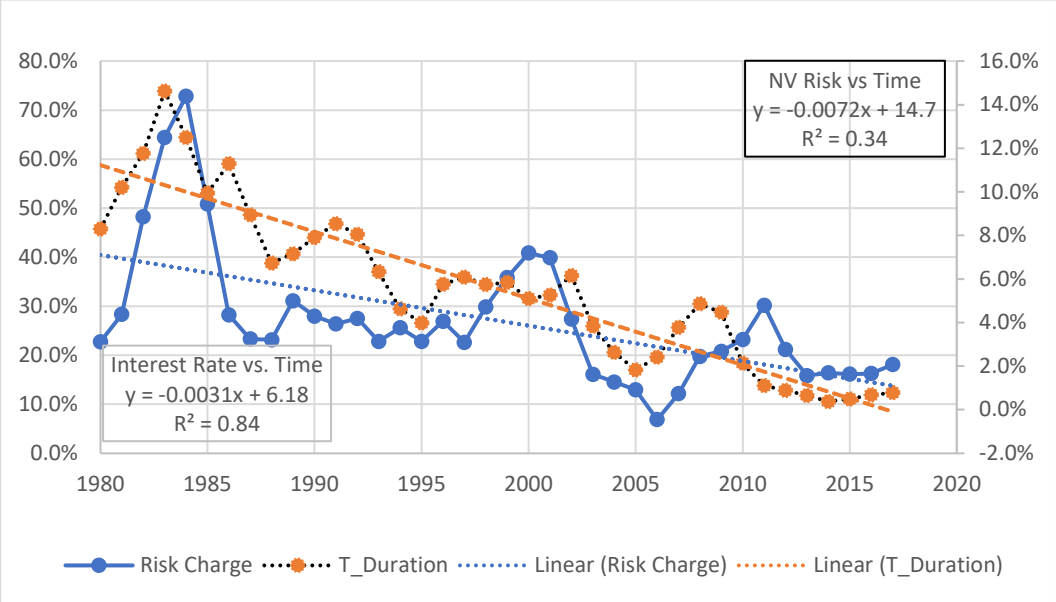
The references "NV Risk" or "Nominal Risk Charge" in the labels refer to undiscounted risk charges.

[42] For each LOB, for each AY or initial reserve year, we calculate the average U.S. Treasury security interest rates for durations that match the payment pattern for the LOB. Different LOBs have different duration-matched interest rates for each year because the longer-tailed LOBs include longer-duration securities, often, but not always, with higher interest rates. Appendix 5 gives an example of the duration matching calculation. The interest rate we use here is the average of the interest rates, by year, for the LOBs in the analysis.

The U.S. Treasury interest rate that we use for a given year is the average of rates during the year two years before the AY/initial reserve year (we refer to that as a two-year lag). For premium risk, this might be interpreted as the average rate during the year before the first policy was written, assuming one-year policies.

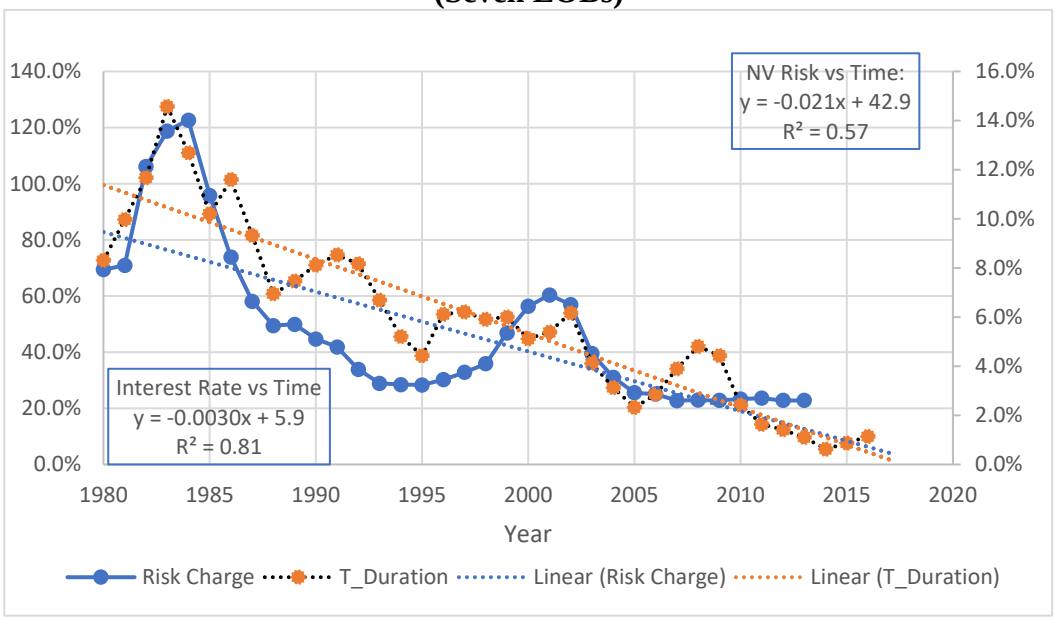
In Appendix 5, we test the extent to which using shorter or longer "lags" and the possibility of multi-year averages affects (a) the relationship between interest rates and indicated undiscounted risk charges and (b) the sensitivity of the indicated risk charges using the Present Value method. For reserve risk, interest rates might, alternatively, have been selected based on the average of the interest rates for the AY components of each year-end reserve. That method would be more complicated to apply, and we did not explore it.

Table 5.2A
Premium: Indicated Undiscounted Risk Charge vs. U.S. Treasury Interest Rates by Year (Eight LOBs)



"NV Risk" in legend = Undiscounted Risk Charge
"T_Duration" in legend = U.S. Treasury interest rates with duration matched by LOB

Table 5.2B
Reserve: Indicated Undiscounted Risk Charge vs. U.S. Treasury Interest Rates by Year (Seven LOBs)



NV Risk in legend = Undiscounted Risk Charge
T_Duration in legend = U.S. Treasury interest rates with duration matched by LOB

In Tables 5.2A and 5.2B, we observe that the shape of the interest rate pattern is similar to that of the risk charge pattern, with an overall decrease over time and ups and downs over the experience period.

Tables 5.3A and 5.3B examine that relationship further.

Table 5.3A
Premium: U.S. Treasury Rates vs. Indicated Undiscounted Risk Charges
(Eight LOBs)

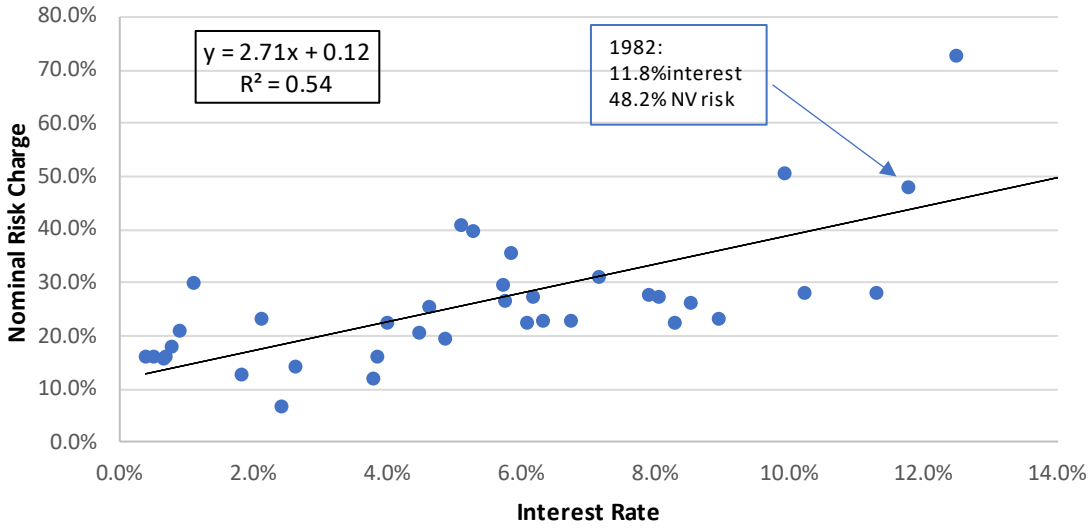
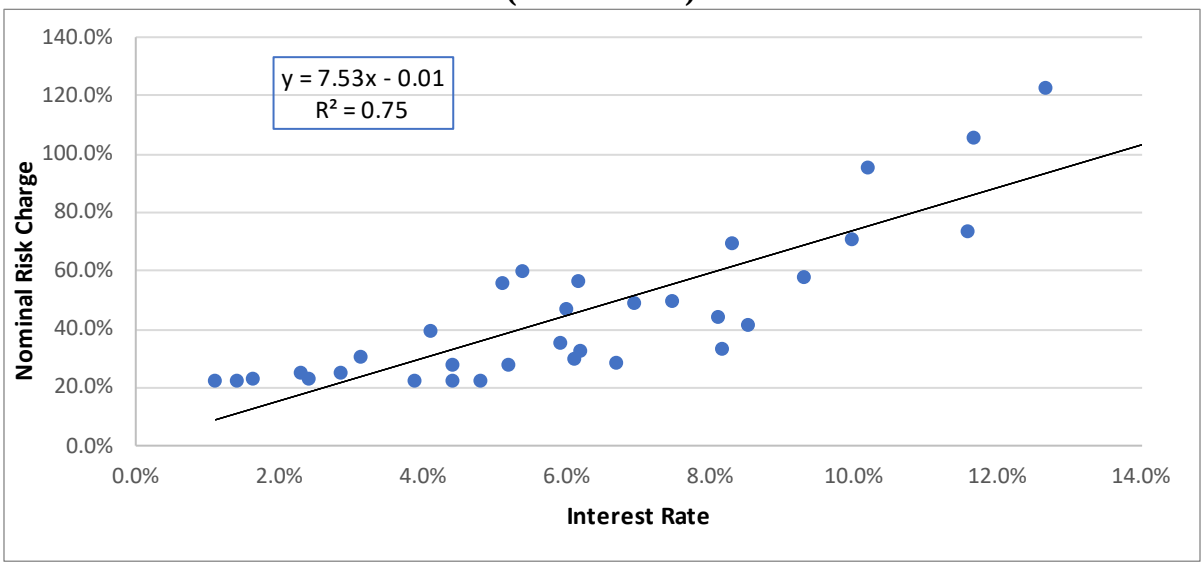


Table 5.3B
Reserves: U.S. Treasury Rates vs. Indicated Undiscounted Risk Charges
(Seven LOBs)



Tables 5.3A and 5.3B above show undiscounted risk charges versus U.S. Treasury rates rather than showing each of the two variables separately relative to time. The horizontal axis shows interest rates. The vertical axis shows indicated undiscounted premium and reserve risk charges. Each point in the scatter chart is a year. For each year, we show the indicated undiscounted risk charge on the Y-axis and the U.S. Treasury duration-matched interest rate on the X-axis. For example, Table 5.3A shows the AY 1982 data point with an interest rate, x value, 11.8%, and an indicated undiscounted risk charge, y value, 48.2%.

The data shows an upward trend, i.e., undiscounted risk charges tend to be higher when interest rates are higher, and vice versa. For premium risk, the R-squared is 54%. For reserve risk, R-squared is 75%.

PV Method

To the extent that interest rates and risk factors are closely related, we might calibrate the combined risk factors and IIAs rather than calibrate the two RBC Formula elements separately. We refer to the calibration of risk factors and interest rates combined as the PV Method. We refer to the resulting indicated risk charge as the PV indicated risk charge.

To calibrate the combined risk charges, we use the 87.5th percentile of the present value of LRs/RRRs, calculated as follows:

- We begin with the filtered LRs/RRRs by company/pool used in the April 2021 Report.
- We calculate the discounted LRs/RRRs.
    - The discounted LR is the present value of the losses in the LR, discounted to the beginning of the AY, divided by the premium.
    - The discounted RRR is the present value of the developed reserves, discounted to the end of the initial reserve year, divided by the undiscounted initial reserve.
    - We use the premium and reserve 40-year runoff payment patterns for the discounting.
    - We use year-by-year interest rates equal to the rates on U.S. Treasury securities with maturities matching the premium and reserve payment patterns by LOB. Appendix 5 includes an example of the duration matching calculation.
- We calculate the year-by-year indicated PV risk charges using the 87.5th percentile of year-by-year discounted LRs/RRRs.[43]

Table 5.4 below shows the variation in year-to-year indicated undiscounted risk charges and PV indicated risk charges.

[43] The PV indicated premium risk charge is the 87.5th percentile discounted loss ratio plus expenses minus 1.0. The PV indicated reserve risk charge is the 87.5th percentile of the discounted RRRs.

Table 5.4A
Premium: Discounted (PV) and Undiscounted (NV) Indicated Risk Charges (Eight LOBs)

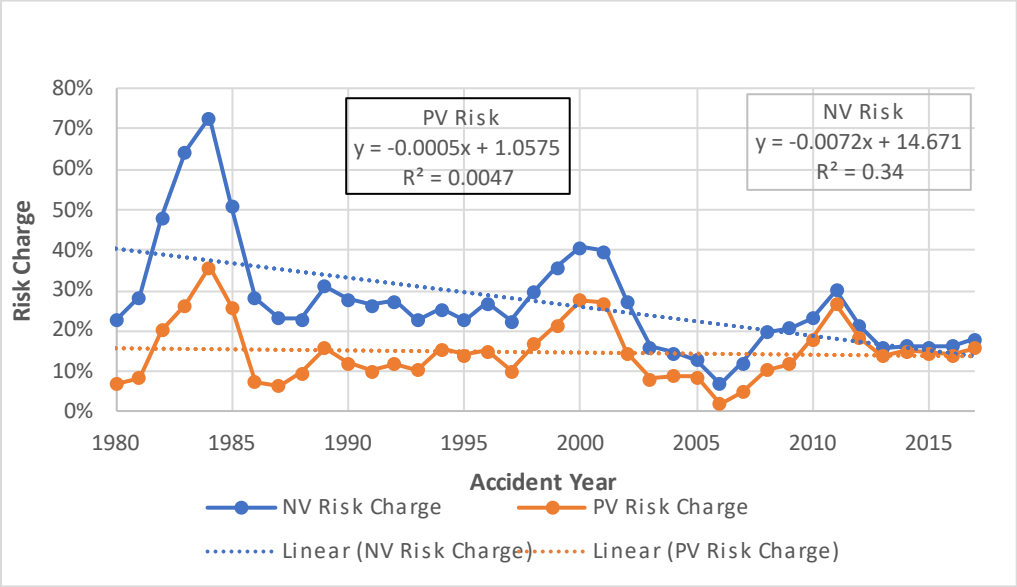
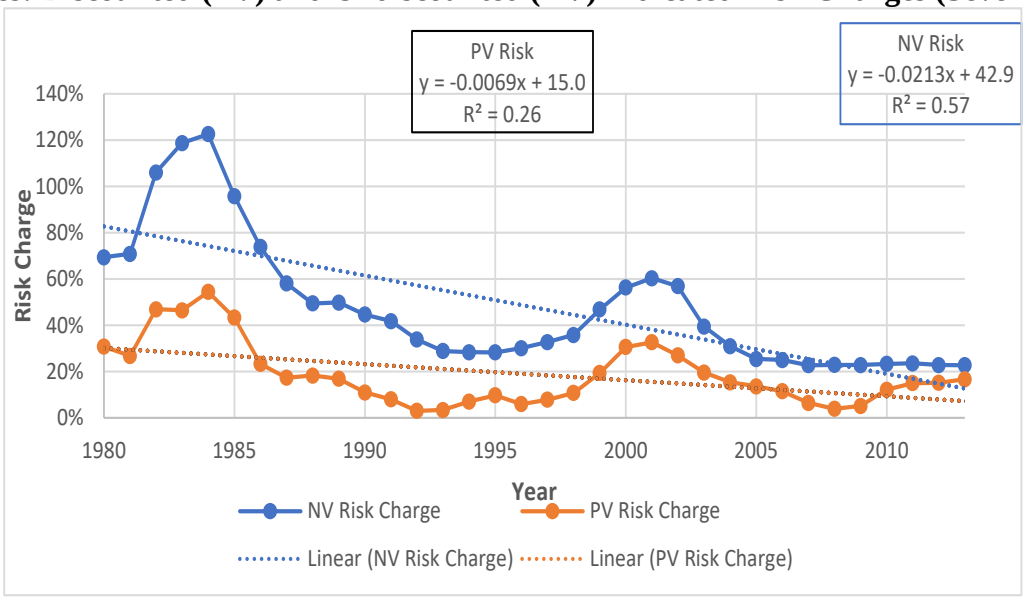


Table 5.4B
Reserves: Discounted (PV) and Undiscounted (NV) Indicated Risk Charges (Seven LOBs)



The PV indicated risk charge pattern shows trend closer to zero over time than the indicated undiscounted risk charge pattern.[44], [45] This pattern suggests that the combined risk factor/IIA

[44] The PV risk charges, being discounted, are lower than the undiscounted risk charges. See Appendix 5, Exhibit A5-3, showing the slopes adjusting for that difference. The slope of PV risk charges remains closer to zero than the slope of the undiscounted risk charges, after adjusting for that difference.

[45] See footnote 44

calibration might have more value in predicting future risk charges than a separate calibration of each element.

Premium Risk

For premium risk, in Table 5.4A, the indicated undiscounted risk charge pattern that we showed in Table 5.1A has a downward slope of 0.72% of premium per year. In contrast, the trend line for the discounted risk charge patterns is downward by only .05% of premium per year.

Reserve Risk

For reserve risk, in Table 5.4B, the indicated undiscounted risk charge pattern we showed in Table 5.1B has a downward slope of 2.1% of reserves per year. In contrast, the trend line for the discounted risk charge patterns is downward by only 0.69% per year.[46]

1980-1987 Experience

We also observe that both the undiscounted indicated and PV indicated risk charges from the earliest years, e.g., 1980-1987, are higher than for later years. In the April 2021 Report,[47] we identified reasons why the experience for those years might not be appropriate for projecting risk levels. Therefore, the indicated risk charges in this report are based on experience from 1988 and subsequent.

Appendix 6 shows LOB data and other information regarding our decision to exclude 1987 and prior years from our analysis.

Conclusion—PV Method

The relationship between interest rates and LRs/RRRs may be specific to the 1980-2017 years and may not be a permanent feature. Nonetheless, the downward trend in indicated undiscounted risk charges is so large that we believe it is necessary to address that through the PV Method or otherwise.

In addition to the data analysis earlier in this section, we observe that the PV Method is plausible in that, particularly over the experience period:

- Target underwriting results may vary inversely with the investment income available. If interest rates are higher, more investment income is available, and insurers might increase their undiscounted target Loss Ratios (LRs). If LRs are higher, the indicated risk charges will tend to be higher.
- Adverse reserve development may have varied with investment income, as reduced underwriting profitability may correlate with lower reserves and/or intentional or unintentional reserve discount, especially in the 1980s and early 1990s.
- High (low) interest rates may imply actual or anticipated high (low) inflation rates that might affect LRs or reserve development.

[46] See footnote 44,

[47] April 2021 Report, pages 17-18 (copied in Appendix 6 to this report) and 27-29.

Moreover, using the PV Method helps address the difficulty we observed in selecting an interest rate for the IIAs.

Therefore, we use the PV indicated risk charges based on 1988 and subsequent years. Future analysis will need to monitor this pattern.

Applying RDHA to PV Indicated Risk Charges

The final PV indicated risk charge is the 87.5th percentile of the discounted LRs/RRRs across all years, plus the RDHA, plus, for premium risk only, expenses minus 1.0. To include the RDHA, we "replace" the effect of present value calculations using the 40-year runoff payment pattern with the effect of present values based on the 40-year truncated payment pattern by LOB. We make that transition using a 4% interest rate, where 4% is the all-line average duration-matched interest rate for 1988 through 2017, the year range of our selected calibration data.[48] We show the RDHA calculations in Appendix 5, Exhibits A5-1A and 1B.

6. PRESENT VALUE INDICATED RISK CHARGES BY LOB

This section examines the indicated LOB risk charges based on the PV Method we discuss in Section 5. Note that the indicated risk charges shown in Section 6 differ from the indicated risk charges shown in Tables 1.1A and 1.1B because the risk charges shown in Section 6 do not reflect the revised catastrophe adjustments, the D-WC tabular adjustments, or the effect of the 5% minimum risk charge.

Analysis of Change—All-Lines Average

We calculate the PV indicated risk charges directly from the raw data, using the 87.5th percentile discounted LRs/RRRs across all years from 1988-2017.

Still, conceptually, we can examine the change in risk charges compared to the current risk charges, as follows:

- Step 1: Change due to loss experience shown in the April 2021 Report, using IIAs in the current RBC Formula.
- Step 2: Step 1 using IIAs based on the 40-year truncated payment patterns retaining the 5% interest rate.
- Step 3: Step 2 with a 4% interest rate.
- Step 4: Apply the PV Method, including the RDHA.

[48] This 4% interest rate happens to be the same as the current interest rate that we discuss in Section 3, but we have derived it differently. The RDHA interest rate is the all-line average duration-matched interest rate from 1988-2017, the range of our calibration data from Schedule P. The current interest rate we use to separate the risk charge into Line 4 and IIA factors is based on current/forecasted interest rates.

In Table 6.1 below, columns 3-5 show the Line 4 risk factor, IIA, and interest rate assumptions that characterize each step.

Table 6.1
Alternative Assumptions Underlying Indicated Risk Charges

(1)	(2)	(3)	(4)	(5)
		Risk Factor Assumptions		
	Description	**Line 4**	**IIAs**	**Interest rate**
Base	Base Risk Factors	Factor in the RBC Formula	Factor in the RBC Formula	5.0%
Step 1	April ’21 Risk Experience Change	April 2021 Report	Factor in the RBC Formula	5.0%
Step 2	Revised Payment Pattern	April 2021 Report	40-year truncated payment pattern	5.0%
Step 3	4% Interest Rate	April 2021 Report	40-year truncated payment pattern	4.0%
Step 4	PV Method	Calibrates Risk Factors and IIAs combined. Uses the 40-year runoff payment pattern and then applies the “difference” between runoff and truncated payment patterns to implement the RDHA. Uses historical U.S. Treasury interest rates with matching durations by LOB.		

Note: Steps 2-4 reflect the RDHA. All steps include current catastrophe adjustment for premium risk.

Table 6.2 below shows the all-line average indicated risk charge at each step.

Table 6.2
All-Lines Average Effect

(1)	(2)	(3)	(4)	(5)		(6)	(7)
Row	**Assumptions**	**Short Label for Table 6.3**	**Risk Charge**			**Incremental % Increase in Risk**	
			Prem	**Rsv**		**Prem**	**Rsv**
1	Current	Current	13.5%	19.5%		0.0%	0.0%
2	Ap '21/ Current IIA	Ap '21	13.0%	21.1%		-3.6%	7.7%
3	Ap '21/5% Interest; 40-year truncated pay pattern	Trunc 5%	13.2%	19.4%		1.1%	-7.7%
4	Ap '21/4% Interest; 40-year truncated	Trunc 4%	14.7%	22.7%		11.3%	17.0%
5	PV Approach	PV	13.7%	19.2%		-6.5%	-15.6%
6	Total Change (5)/(1)-1.0%	Total	13.7%	19.2%		1.4%	-1.8%

Premium risk charge includes current catastrophe adjustments. Labels in column 3 are the same as in Table 2.2.

Rows 3 and 4 use the 40-year truncated payment pattern and, therefore, include the RDHA. The PV indicated risk charge in row 5 includes the RDHA based on the calculations we show in Appendix 5.

Row 6 shows that the overall change, applying the PV Method, is a small increase in premium risk and a small decrease in reserve risk, as follows:

- An increase equal to 1.4% in the premium risk charge, and
- A decrease equal to 1.8% in the reserve risk charge.

For premium risk, column 6, rows 2, 3, and 4 show that the incremental percentage changes are -3.6% due to the risk experience observed in the April 2021 report, +1.1% from updating the payment patterns, +11.3% in using a 4% interest rate rather than 5% interest rate,[49] and -6.5% in moving to the PV Method. Thus, the PV Method offsets more than half of the increase due to the interest rate change.

For reserve risk, column 7, rows 2, 3, and 4 show that the incremental changes are +7.7% due to risk experience observed in the April 2021 report, -7.7% due to updating the payment pattern, +17.0% in using a 4% interest rate rather than a 5% interest rate, and -15.6% in moving to the PV Method. Thus, using the PV Method largely offsets the increase due to the interest rate change.

Analysis of Change—Risk Charges by LOB

Tables 6.3A and 6.3B provide the same analysis as Table 6.2 by LOB. Columns 2-6 in Tables 6.3A and 6.3B correspond to rows 1-5 in Table 6.2.

For each LOB, we highlight the column with the largest change in risk charges as a percentage of premium or reserves.

[49] The "effect of using a 4% interest rate" means the "effect if we used a 4% interest rate and did not apply the PV Method." When we use the PV Method, the current interest rate is not a significant element of the risk charge.

Table 6.3A
Premium: Indicated Risk Charges by LOB
Listed in Order of Decreasing Indicated Change—Column 7

(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)
	Indicated Premium Risk Charge						Change in Risk Charge	
LOB	Current	Ap '21	Trunc 5%	Trunc 4%	PV		% Risk (6)/(2)-100%	% Prem (6)-(2)
T-Wrnty	3.0%	13.9%	20.0%	20.6%	21.6%		619.0%	18.6%
S-FG/MG	75.4%	162.9%	162.1%	167.7%	153.4%		103.5%	78.0%
M-Intl	55.6%	98.8%	100.4%	103.1%	94.3%		69.7%	38.7%
F2-MPL-C	18.9%	20.5%	21.9%	25.2%	24.4%		29.0%	5.5%
J-APD	4.4%	4.5%	4.8%	5.2%	5.4%		23.9%	1.1%
G-SL	16.6%	17.9%	19.2%	20.7%	18.9%		13.6%	2.3%
B-PPA	12.5%	13.0%	12.8%	14.2%	13.7%		10.3%	1.3%
C-CA	18.5%	19.5%	18.7%	20.9%	20.1%		9.1%	1.7%
E-CMP	14.8%	14.4%	15.3%	16.8%	15.9%		7.8%	1.1%
N-Re-Prop	31.2%	31.3%	32.6%	34.6%	33.5%		7.4%	2.3%
H-OL	13.0%	13.1%	13.0%	16.2%	13.5%		3.8%	0.5%
A-HO	18.2%	17.8%	18.2%	18.9%	18.6%		2.0%	0.4%
L-Other	14.2%	14.0%	14.1%	15.0%	14.3%		1.2%	0.2%
R-PL	30.7%	31.3%	32.2%	37.0%	28.6%		-6.8%	-2.1%
D-WC	13.8%	12.6%	12.3%	15.2%	12.0%		-12.6%	-1.7%
O-Re-Liab	29.5%	24.0%	27.9%	32.0%	23.0%		-21.8%	-6.4%
F1-MPL-O	53.4%	39.0%	39.1%	45.0%	36.3%		-32.1%	-17.1%
I-SP	12.0%	7.5%	7.3%	8.2%	7.9%		-33.8%	-4.1%
K-Fid/Sur	27.2%	10.2%	10.3%	11.5%	10.6%		-61.0%	-16.6%
Avg	13.5%	13.0%	13.2%	14.7%	13.7%		1.4%	0.2%

Premium risk includes current catastrophe adjustment.

Columns 4-6 include RDHA.

For premium risk, we see that the experience change (column 3) is responsible for the three largest decreases and the three largest increases by LOB. The change in interest rate from 5% to 4% (column 5) has the greatest effect on 9 of the 19 LOBs.

Table 6.3B
Reserves: Indicated Risk Charges by LOB
Listed in Order of Decreasing Indicated Change—Column 7

(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)
	Indicated Reserve Risk Charge						Change in Risk Charge	
LOB	Current	Ap '21	Trunc 5%	Trunc 4%	PV		% Risk (6)/(2)-100%	% Rsv (6)-(2)
M-Intl	18.8%	78.7%	81.6%	85.7%	85.1%		353.5%	66.4%
R-PL	51.5%	107.9%	105.9%	113.1%	101.3%		96.6%	49.8%
C-CA	16.2%	24.0%	24.1%	26.3%	25.9%		59.5%	9.7%
K-Fid/Sur	28.9%	50.4%	42.5%	45.6%	44.0%		52.5%	15.2%
G-SL	16.1%	25.9%	24.5%	27.5%	23.9%		48.8%	7.8%
B-PPA	9.4%	11.5%	11.0%	12.7%	12.9%		37.6%	3.5%
A-HO	13.8%	14.7%	15.1%	16.4%	16.6%		20.4%	2.8%
E-CMP	30.9%	31.3%	32.7%	35.7%	32.5%		5.2%	1.6%
I-SP	20.4%	23.4%	20.6%	21.9%	21.3%		4.6%	0.9%
T-Wrnty	28.9%	23.4%	24.9%	26.1%	30.2%		4.6%	1.3%
H-OL	30.4%	30.1%	29.8%	33.9%	29.2%		-4.0%	-1.2%
J-APD	12.7%	10.5%	10.2%	10.8%	11.2%		-12.1%	-1.5%
L-Other	18.0%	18.5%	13.0%	14.7%	14.7%		-18.5%	-3.3%
N-Re-Prop	27.5%	21.0%	21.2%	23.5%	20.4%		-25.7%	-7.1%
O-Re-Liab	38.8%	37.1%	31.3%	36.9%	26.5%		-31.6%	-12.2%
F1-MPL-O	19.6%	9.4%	6.9%	10.4%	9.4%		-52.1%	-10.2%
D-WC	11.6%	10.8%	6.7%	11.3%	4.6%		-60.0%	-6.9%
F2-MPL-C	12.7%	-3.4%	-3.6%	-1.3%	-0.9%		-106.9%	-13.5%
S-FG/MG	9.2%	-7.3%	-10.0%	-8.2%	-5.0%		-154.9%	-14.2%
Avg	19.5%	21.1%	19.4%	22.7%	19.2%		-1.8%	-0.4%

Columns 4-6 include RDHA.

For reserve risk, we see that the experience change (column 2) has the largest effect on 13 of the 19 LOBs, including the six LOBs with the largest increases and the two LOBs with the largest reductions.

The indicated risk charges for S-FG/MG and F2-MPL-C are more than 100% lower than the current risk charges. This is possible because the PV indicated risk charges for those LOBs are negative.[50]

[50] Negative risk charges arise when the amount of investment income implied by the IIAs is larger than the 87.5th percentile UW loss or adverse development.

7. ADJUSTMENT FOR CATASTROPHE RISK REFLECTED IN R_{CAT}

Beginning with year-end 2017 reporting, the RBC Formula includes a new risk component, R_{CAT}, covering earthquake and hurricane components of the total premium risk.[51]

As in prior Academy reports, we determine the indicated premium risk factors with data that includes earthquake and hurricane losses ("catastrophe losses").[52] Therefore, we reduce the otherwise applicable premium risk factors for the catastrophe-affected LOBs to avoid double-counting catastrophe risk. We refer to this reduction as the catastrophe adjustment. There is no catastrophe adjustment for reserve risk factors because R_{CAT} applies to premium risk (the modeled risk of future earthquakes and hurricanes) and not to reserve risk (the risk of adverse development on losses from earthquakes and hurricanes that have already occurred).

The R_{CAT} instructions in RBC provide that "…the company's own insured **property** [emphasis added] exposure information should be used as inputs to the model(s)."[53] We understand that this means that the modeling for R_{CAT} should include all property damage related to hurricane and earthquake events and that reported hurricane and earthquake losses should do the same. As a practical matter, some elements of catastrophe modeling are less sophisticated than other elements, e.g., hurricane exposures from storm surge, loss to movable property in marine and other LOBs, and automobile physical damage. A key assumption in our analysis is that the modeling includes reasonable provisions for all losses of the types that are reported in the catastrophe experience.

For our review, using the confidential RBC Filings, regulators first collected total LRs, catastrophe only LRs, and LRs excluding catastrophe losses (non-catastrophe losses). This information was collected by individual company, LOB, and AY for AYs 2004-2017. They then edited this information to remove suspected erroneous entries.[54] Following instructions from this Committee, regulators consolidated the company data into company-pools, as appropriate, and filtered the remaining records to match the filtering used by the Committee in its Line 4 calibration for premium risk.[55] The regulators provided blinded aggregated data to this Committee, summarized by LOB and AY and by LOB overall for AYs 2004-2017, for the LOBs for which companies report hurricane or earthquake property claims in the confidential RBC Filings in RBC Forms PR 100-122.

Table 7.1 below summarizes our analysis.

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[51] The NAIC P&C RBC Committee Catastrophe Risk (E) Subgroup annually publishes a catastrophe event list on its website to guide companies as to which events from the most recent 10 years should be included in their catastrophe experience disclosed in PR101, etc. These events include US and non-U.S. earthquakes, hurricanes, and tropical storms, consistent with the perils modeled for R_{CAT} (August 2017 CIPR Newsletter).

[52] The data to allow separation of losses from relevant catastrophe events from all losses is available only in the insurer's confidential RBC Filings, and, therefore, it is not available to the Academy on the company-by-company basis the Academy uses in its calibration.

[53] Refer to 2022 NAIC P&C RBC Instructions for forms PR027A and PR027B, see pages 99 and 100 of the pdf.

[54] Erroneous entries are a particular issue in this data because the R_{CAT} element of the RBC Formula was new to companies, and for the earliest AYs (2004-2007), the R_{CAT} data was collected on an "informational" basis only.

[55] Based on the filtering rules we described in the Committee's April 2021 Report.

Table 7.1
Premium Risk: Current and Indicated Catastrophe Adjustments
Based on AY 2004-2017 Data from Confidential RBC Filings

(1)	(2)	(3)	(4)	(5)=(3)-(4)	(6)	(7)=(3)+Exp-100%	(8)=(6)/(7)
LOB	Current Cat Adjustment	87.5th Total LR	87.5th Non Cat LR	Indicated Cat Adjustment	Selected Cat Adjustment	87.5th Total Risk Charge	Cat Adj As % of Risk Charge
A-HO	2.8%	91.5%	88.9%	2.6%	2.6%	20.4%	12.7%
E-CMP	1.8%	83.3%	81.7%	1.6%	1.6%	18.9%	8.6%
G-SL	1.6%	96.0%	91.7%	4.3%	4.3%	29.8%	14.4%
I-SP	1.6%	82.8%	79.4%	3.4%	3.4%	12.9%	26.3%
J-APD	0.0%	84.8%	84.2%	0.6%	0.6%	8.0%	7.5%
M-Intl	0.0%	192.1%	159.3%	32.8%	15.0%	136.0%	11.0%
N-Re-Prop	6.9%	122.1%	96.2%	25.9%	25.9%	48.8%	53.0%
O-Re-Liab	0.0%	100.5%	100.2%	0.4%	0.4%	27.2%	1.3%
R-PL	0.0%	100.8%	100.6%	0.3%	0.0%	33.8%	0.0%

Source: AYs 2004-2017 from RBC Filings 2013-2017

The columns in Table 7.1 are as follows:

- Column 2 shows the current (i.e., incumbent) catastrophe adjustment, expressed as a percentage of premium, to be subtracted from otherwise indicated premium risk factors.[56]
- Column 3 shows the 87.5th percentile of company/year total (catastrophe + non-catastrophe) LRs by LOB for premium risk data points from AYs 2004-2017 that satisfy the Line 4 calibration filters.
- Column 4 shows the 87.5th percentile of company/year non-catastrophe LRs by LOB for company years from AYs 2004-2017 that satisfy the Line 4 calibration filters.
- Column 5 is the raw indicated catastrophe adjustment. This column equals the difference between the 87.5th percentile LR, including catastrophes (column 3), and the 87.5th percentile LR excluding catastrophes (column 4), both from the filtered data set.
- Column 6 shows the catastrophe adjustments selected by the Committee, selected as follows:
    - For most LOBs, we selected the indicated adjustments from column 5: A-HO, E-CMP, G-SL, I-SP, J-APD, N-Re-Prop, and O-Re-Liab.
    - For M-Intl, we selected 15%, only about half of the indicated catastrophe adjustment because the indicated adjustment is based on a small number of data points and other features of the M-Intl data that we describe in Appendix 7.

[56] In past reviews, the Academy expressed the adjustment as a multiplicative adjustment to the risk factor. The factor reductions are A-HO=0.971, E-CMP=0.980, G-SL=0.983, I-SP=0.982, and N-Re-Prop=0.944. Table 7.1 shows the reduction as an equivalent amount to subtract from the Line 4 risk factor.

- For R-PL, we select a 0% adjustment because R-PL has a small indicated catastrophe adjustment and is not expected to be exposed to property catastrophes.[57]

The largest impact of the catastrophe adjustments as a percent of premium is for M-Intl and N-Re-Prop.

- Column 7 shows the indicated undiscounted risk charge for AYs 2004-2017 based on column 3. Column 7 equals column 3 plus the 2017 LOB industry average expense ratio (Table 1.1A column 3) minus 100%.
- Column 8 equals column 6 divided by column 7 and is the proportion of the risk charge driven by catastrophe losses. The column 8 ratio is highest for N-Re-Prop, which is unsurprising.

The analysis in this Report is the first review of the catastrophe adjustments by the Academy, and the documentation for the current (i.e., incumbent) catastrophe adjustments is limited. Therefore, we do not evaluate the reasons for the differences between the current adjustments in column 2 and the indicated adjustments in column 5.

In Appendix 7, we describe our analysis and important limitations that relate to the data we use.

Appendix 9 shows our instructions to the Regulators to collect blinded data for Ten-Year LOBs from the confidential RBC Filings for catastrophe adjustment purposes.

8. WC TABULAR RESERVE ADJUSTMENT

Generally, for Annual Statement purposes, P&C insurance companies report reserves on an undiscounted basis, but there are some exceptions. Most importantly for our analysis, companies are permitted to report D-WC reserves discounted to reflect tabular reserves for lifetime annuity claims (tabular discount).[58] This section discusses the effect of discounting on calibration of RBC factors and on the operation of the RBC Formula.

Background

In our calibration, we intend that:

- The IIA reflects all potential investment income.
- Risk factors reflect adverse loss ratios and adverse reserve development gross of any discount.

[57] O-Re-Liab, on the other hand, can include catastrophe-exposed business on reinsurance contracts that cover both property and liability exposures therefore the small but non-zero indicated cat adjustment is reasonable for O-Re-Liab.

[58] There may be tabular discounts in other LOBs, for example, for excess WC that is reported in the OL LOB. We do not make adjustments on those LOBs.

We use Schedule P Part 2 incurred losses[59] to calibrate reserve risk charges. We use Schedule P Part 1 loss ratios to calibrate premium risk charges.

The RBC Formula uses Schedule P Part 1 net written premium and net loss and LAE reserves as the base against which the risk charges are applied.

Non-Tabular Discount

Some companies are allowed to reflect non-tabular reserve in their statutory financial statements. This does not affect our calibration or the operation of the RBC Formula because:

- Schedule P, Part 2, which we use to calibrate reserve risk charges, is gross of non-tabular discount for all companies. Therefore, the RRRs in our calibration are gross of discount, as intended.
- Schedule P, Part 1, includes data both net and gross of non-tabular discount. The calibration data and key RBC Formulas use the data gross of non-tabular discount, so neither is affected by any such discount.

Thus, in our work, there is no need for adjustments related to non-tabular reserves.

Tabular Reserve

Some companies report WC reserves with tabular discount, and others report on an undiscounted basis. On average, the tabular discount is 3.4% of reserves at December 31, 2017, and 0.6% of premium for the 2008 LR, the most mature AY at 2017.

The tabular discount is reflected in Schedule P as follows:

1. As is the situation for non-tabular reserve discounting, Schedule P, Part 2, which we use to calibrate reserve risk factors, is gross of discount for all companies.
2. Unlike the situation with non-tabular reserve discounting, Schedule P, Part 1, reserves and LRs, are lower, all else being equal, for companies that reflect tabular discount in their reserves. The discount amount is not provided in Schedule P Part 1.

Item 1 means that our calibration of reserve risk factors is based on undiscounted data, as we intend.

Item 2 has two effects on our calibration:

- For premium risk calibration: The mature LRs we use in our calibration are reduced by the non-tabular discount remaining at year 10. We intend to produce an 87.5^{th} percentile LR that is undiscounted. Based on the average difference between the discounted and undiscounted LRs at 10 years, we increase the indicated premium risk factor by 0.6% of premium.

[59] We also use Schedule P Part 2, paid losses, but the paid losses are not affected by reserve discounting.

- For reserve risk calibration: In the RBC Formula, the reserve risk factors are applied to loss and LAE from Schedule P, Part 1.[60]

  We calibrate the reserve risk charge assuming it will be applied to reserves gross of discount. Since this is not the case, we adjust the risk factor to offset the lower reserves.

  Table 8.1 shows how we determine the adjustment.

Table 8.1
Risk Factor Adjustment for Tabular Reserves

Row	Item	Am't	Discussion
	A. Data and Parameters		
1	Carried Reserve $	$ 96.71	Selected base
2	Undiscounted Reserve $	$ 100.00	Assuming tabular discount is 3.4% of carried reserve; (2) = (1) * 1.034
3	Indicated Risk Charge %	4.6%	PV Indicated WC reserve risk charge, with RDHA. Calibrated to be applied to undiscounted reserves
	B. Calculation of adjusted risk charge		
4	Total assets requried for reserve runoff including 87.th percentile adverse development $	$ 104.60	(4) = (1+ (3))*(2)
5	Reserve RBC $ above carried reserve	$ 7.89	(5) = (4) - (1)
6	Risk Charge applied to carried reserve %	8.2%	(6) = (5) / (1)
7	Alternate calculation %	8.2%	(7) = [(1+ (3)) * (2)/(1)] - 1.0 i.e., (1+ .046) * 1.034 -1.0

In row 1 we assume the carried reserve is $96.71, reduced from $100 by the tabular reserve discount. Then, in row 3, we assume that our calibration based on Schedule P data that produced a PV indicated risk charge of 4.6%. The 4.6% charge means that $104.60 is the asset level required such that $104.60 plus the investment income on the $104.60 would cover the expected payout plus the 87.5th percentile adverse development.

The risk charge is applied to the Schedule P reserve, $97.61. To produce the $104.60 indicated level, the risk charge is $104.60 / 97.61 – 1.0 = .082, or 8.2%, shown in row 6.

We use this adjustment, but we note that it may not be correct for any company. For companies that do not discount, no adjustment is necessary, and the risk charge should be 4.6%, not 8.2%. For companies that do discount, the effect of the discount is likely to be more the 3.4%, so for them, the adjusted risk charge should be more than 8.2%.

[60] Adjusted for certain medical tabular reserves (Lines 6 and 7 of the PR017). The adjustment accounts for under 0.01% of the observed tabular reserve discount.

Tabular Reserve—Effect of Total Adjusted Capital

The base case is that there is no discounting, tabular or non-tabular.

Compared to the base case, if a company is allowed to discount reserve, tabular or otherwise, the balance sheet reserve is lower and reported capital is higher.

If a company has a non-tabular discount, the RBC Formula reduces TAC by the amount of that discount. So, a company RBC value and TAC are not affected by whether the company has a non-tabular discount in its reserves.

On the other hand, if a company has a tabular discount, the RBC Formula has no reduction in TAC. Two RBC implications of that are the following:

- For otherwise identical companies, the RBC position of companies that discount is more favorable than the RBC position of companies that do discount.
- The potential future investment income in the tabular reserve is double counted. It is counted once in capital and TAC, which have been increased by the tabular reserve amount, 3.4% of reserves on average. It is counted a second time because the IIA is intended to incorporate all future investment income.[61]

Alternative RBC Treatment of Tabular Discount

If the RBC treatment of tabular discount were the same as the treatment of non-tabular discount, then:

- The RBC positions of companies would not be affected by whether they included a tabular discount in their reserves.
- The double counting of investment income would be eliminated in TAC and IIAs.

This is a policy matter for the NAIC.

9. SAFETY LEVEL CALCULATIONS

We use the 87.5th percentile safety level to determine the indicated risk charges at the CAL. Using the 87.5th percentile safety level means that, for each LOB, looking across LRs or RRR data points, by year and by company (or pool), the risk charges are set at the point where 12.5% of the data points are above the premium risk factor or reserve runoff ratio, and 87.5% of the data points are below. The 87.5% safety level can also be called a one-in-eight safety level. The 87.5th percentile safety level is consistent with prior calibrations by this Committee.

[61] Note that we use the truncated payment pattern, so it might appear that we have limited the investment income to less than the full potential. That is not the case. The difference between the full runoff investment income and the truncated investment income is an increase in risk factors indicated because of the expected upward development of the risk factors observed within the 10-year window available from Schedule P.

The 2007 Committee Report[62] describes the origin of the 87.5th percentile safety level. We understand that in the initial stages of development, the NAIC targeted a 90th percentile (1 in 10) safety level[63] but used various rules of thumb to select the factors. When the Committee first played a role in recalibrating the premium and reserve risk factors in 2007, the Committee found that an 87.5% safety level reproduced the overall level of the risk factors.[64]

There have been Working Group discussions about the appropriate safety level to use in various components of the RBC formula. To support potential future discussion about safety levels to use for the reserve and premium risk charges, but not to take a position on changing the safety level, within this section we compare indicated risk charges using the current safety level of 87.5% to two higher safety levels, 90%, and 95%. These results should not be used as the basis for increasing the safety level. Increasing the safety level is a policy decision for regulators. After the results, we also provide considerations for keeping or changing the 87.5% safety level, which we determined as an outcome of this analysis. These may be useful to regulators in future discussions about safety levels.

Tables 9.1A and 9.1B below show indicated premium and reserve risk charges at the 87.5th, 90th, and 95th percentile safety levels. On average, the effects on risk charges of using the indicated 90th percentile safety level rather than the 87.5th percentile safety levels are increases of 26% and 37% of the risk charge for premium and reserve risk, respectively. The corresponding effects at the 95th percentile safety level are increases of 117% and 175% for premium and reserve risk, respectively. In columns 6– 8, we highlight the LOBs with the three largest (red and bold) and three smallest (green and not bold) increases due to safety level changes.

[62] "An Update to P/C Risk-Based Capital Underwriting Factors: September 2007 Report To The National Association of Insurance Commissioners P/C Risk-Based Capital Working Group," P/C Risk-Based Capital Committee (PCRBC), American Academy of Actuaries, Sept. 2007, pp2-6.

[63] Using the one in 10 safety level may have been in part because Schedule P, used for calibration purposes, had only 10 years of experience for LRs and RRRs. See Kaufman and Liebers, "NAIC RBC Efforts 1990-91," pp152 and 159.

[64] On p6 of its 2007 Report, the PCRBC stated: "The 87.5 percentile was selected because it presents a conservative view of the risk in each line but is also broadly consistent with the existing factors."

Table 9.1A
Premiums: Indicated Risk Charges at Various Safety Levels

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LOB	Current Risk Charge	PV Indicated risk Charges			(4)/(2)-1	(4)/(3)-1	(5)/(3)-1
		Premium			90 v current	90 v 87.5	95 v 87.5
		87.5th	90th	95th			
A-HO	18.2%	18.8%	21.9%	34.0%	20%	17%	81%
B-PPA	12.5%	13.7%	16.2%	24.6%	30%	18%	79%
C-CA	18.5%	20.1%	24.2%	38.3%	31%	20%	90%
D-WC	13.8%	12.5%	16.1%	27.2%	17%	29%	117%
E-CMP	14.8%	16.1%	19.1%	29.5%	29%	19%	84%
F1-MPL-O	**53.4%**	36.3%	42.9%	69.3%	-20%	18%	91%
F2-MPL-C	18.9%	24.4%	30.0%	46.4%	58%	23%	90%
G-SL	16.6%	16.4%	22.4%	30.1%	35%	37%	84%
H-OL	13.0%	13.5%	19.1%	39.0%	47%	41%	188%
I-SP	**12.0%**	6.2%	9.5%	23.3%	-21%	**54%**	**275%**
J-APD	4.4%	4.9%	7.3%	15.4%	66%	**51%**	217%
K-Fid/Sur	**27.2%**	10.6%	16.0%	35.8%	-41%	**51%**	**238%**
L-Other	14.2%	14.3%	18.8%	35.8%	33%	31%	150%
M-Intl	55.6%	80.4%	117.5%	184.4%	**111%**	46%	129%
N-Re-Prop	**31.2%**	16.1%	24.0%	57.0%	-23%	49%	**254%**
O-Re-Liab	29.5%	22.7%	31.0%	54.5%	5%	36%	140%
R-PL	30.7%	28.6%	40.4%	91.8%	31%	41%	221%
S-FG/MG	75.4%	153.4%	177.7%	374.0%	**136%**	16%	144%
T-Wrnty	3.0%	21.6%	28.9%	37.4%	**862%**	34%	73%
Avg	13.5%	13.3%	16.7%	28.8%	24%	26%	117%

Including RDHA. Before the application of minimum risk charges. Net of indicated catastrophe adjustment developed in Section 8. Including D-WC Tabular reserve adjustment.

Note that as the safety level increases, the data for some LOBs may not be adequate to make the "empirical approach" sufficiently stable. We have not explored that issue.

Table 9.1B
Reserves: Indicated Risk Charges at Various Safety Levels

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LOB	Current Risk Charge	PV Indicated risk Charges Reserve			(4)/(2)-1	(4)/(3)-1	(5)/(3)-1
		87.5th	90th	95th	90 v current	90 v 87.5	95 v 87.5
A-HO	13.8%	16.6%	22.6%	47.0%	64%	36%	184%
B-PPA	9.4%	12.9%	17.8%	35.7%	89%	37%	176%
C-CA	16.2%	25.9%	32.4%	60.0%	99%	*25%*	*132%*
D-WC	11.6%	8.2%	12.8%	28.4%	10%	56%	247%
E-CMP	30.9%	32.5%	39.9%	72.1%	29%	*23%*	*122%*
F1-MPL-O	**19.6%**	9.4%	16.2%	40.4%	*-17%*	**72%**	330%
F2-MPL-C	**12.7%**	-0.9%	4.6%	24.7%	*-64%*	NM	NM
G-SL	16.1%	23.9%	30.7%	60.3%	91%	29%	152%
H-OL	30.4%	29.2%	39.1%	73.1%	28%	34%	150%
I-SP	20.4%	21.3%	31.6%	66.9%	55%	48%	214%
J-APD	12.7%	11.2%	20.5%	59.3%	61%	**84%**	**430%**
K-Fid/Sur	28.9%	44.0%	69.8%	144.1%	**142%**	**58%**	227%
L-Other	18.0%	14.7%	22.5%	54.8%	25%	54%	274%
M-Intl	18.8%	85.1%	113.8%	423.1%	**506%**	34%	**397%**
N-Re-Prop	27.5%	20.4%	28.9%	59.8%	5%	42%	193%
O-Re-Liab	38.8%	26.5%	39.1%	88.2%	1%	47%	232%
R-PL	51.5%	101.3%	128.0%	231.3%	**148%**	*26%*	*128%*
S-FG/MG	**9.2%**	-5.0%	-1.5%	36.3%	*-116%*	NM	NM
T-Wrnty	28.9%	30.2%	46.2%	262.0%	60%	53%	**768%**
Avg	19.5%	20.1%	27.5%	55.2%	41%	37%	175%

Including RDHA. Before the application of minimum risk charges. Net of indicated catastrophe adjustment developed in Section 8. Including D-WC Tabular reserve adjustment.

Note that as the safety level increases, the data for some LOBs may not be adequate to make the "empirical approach" sufficiently stable. We have not explored that issue.

For F2-MPL-C and S-FG/MG, for reserve risk, comparisons of 90th and 95th percentile safety levels to the 87.5th percentile safety level are not meaningful (NM) because the 87.5th percentile indicated risk charge is negative. Negative indicated risk charges arise when the investment income projected by the IIA is larger than the undiscounted risk charge. In those cases, the risk charge would be increased to a minimum selected by the NAIC.

We can use Table 9.1 to assess how adequate/inadequate risk charges are from an implied safety level perspective. In column 2, we mark LOBs where the current risk charges are above the 90th indicated percentile level (yellow and bold) or within 10% of the 90th percentile level (yellow but not bold). These are the LOBs where risk charges are particularly high relative to an 87.5th percentile safety level.

Table 9.2 shows the NAIC calculation of the change in indicated risk charges by Type of Company[65] produced by the changes in safety levels. The highlighted cells mark the two Types of Company that have the largest changes. The row "Current to 90" shows the percentage increase in indicated risk charge from the current risk charges to the 90th percentile. The row "87.5 to 90" shows the percentage increase in indicated risk charge from the 87.5th percentile to the 90th percentile. The "90 to 95" row shows the percentage increase in indicated risk charge from the 90th percentile to the 95th percentile. The row "87.5 to 95" shows the percentage increase in indicated risk charge from the 87.5th percentile to the 95th percentile.

Examining the lower section, "ACL," and the row "87.5 to 90," we see that the greatest impact of increasing safety levels is on the WC and NOC Types of Company. Considering reserve risk alone, in the top section, the greatest impact from increasing safety levels is also on WC and NOC Types of Company. Considering premium risk alone, the greatest impact from increasing safety levels is on NOC and Reinsurance Types of Company.

Table 9.2
From NAIC Impact Analysis
% Increase in Premium, Reserve, and ACL Amount with Increasing Safety Level

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Risk	Change	Commercial	Med Prof Liab	NOC	Personal	Re	WC	Total
Reserve	87.5- $B	78.3	2.3	0.6	26.8	3.1	12.3	123.4
	Current to 90	35.6%	-38.8%	76.2%	51.9%	14.8%	9.6%	34.8%
	87.5 to 90	32.5%	27.2%	45.3%	36.1%	41.5%	47.8%	34.7%
	90 to 95	91.3%	220.7%	104.6%	101.8%	125.3%	118.9%	98.0%
	87.5 to 95	153.4%	308.0%	197.3%	174.6%	218.8%	223.4%	166.7%
Prem	87.5- $	33.9	1.5	0.7	32.1	0.7	5.5	74.4
	Current to 90	19.2%	25.6%	5.9%	27.6%	10.4%	15.9%	22.5%
	87.5 to 90	25.0%	19.6%	28.6%	22.5%	44.4%	21.5%	23.7%
	90 to 95	73.4%	52.4%	68.9%	67.4%	100.7%	58.1%	69.4%
	87.5 to 95	116.8%	82.2%	117.2%	105.0%	189.8%	92.1%	109.5%
ACL	87.5- $	64.9	2.4	0.9	84.3	8.2	10.1	170.6
	Current to 90	20.6%	-6.5%	22.7%	6.4%	1.5%	7.0%	11.5%
	87.5 to 90	19.6%	8.8%	21.0%	4.8%	3.8%	21.6%	11.4%
	90 to 95	64.1%	61.4%	56.1%	20.1%	20.0%	72.2%	41.8%
	87.5 to 95	96.2%	75.7%	88.9%	25.9%	24.6%	109.4%	58.0%

Using a 5% minimum risk charge and indicated catastrophe adjustments.

[65] Defined in Section 1 and Appendix 8.

Potential Considerations for Keeping the Safety Level at 87.5%:

1. The effective safety level is higher than the explicit 87.5th percentile target because:

   - Some regulatory solvency formulas are calibrated to achieve their target safety level using a one-year time horizon for reserve risk and a one-year time horizon for underwriting profitability. All else being equal, the capital required for a safety level on a one-year time horizon will be lower than the capital required for a safety level, nominally the same, on a runoff basis. RBC uses the more stringent runoff time horizon for reserve risk.[66]
   - Collectively, larger companies have lower indicated risk charges than smaller and mid-sized companies because indicated risk charges by LOB are lower for companies with higher volume in that LOB.[67] The larger companies constitute a disproportionately larger number of policyholders. Therefore, most policyholders are insured with companies whose RBC level implies a higher than targeted safety level.

2. An important purpose of the RBC Formula is to allow regulators to identify and act on weakly capitalized companies. Regulators may believe the current level of RBC is adequate for that purpose.

3. Another purpose of RBC, expressed in the past, is that RBC should provide enough to fund the runoff of losses on companies identified as too troubled to continue operations, and regulators may believe that the current level of RBC has been adequate for that purpose.

4. Most companies operate with capital that is multiples of RBC levels. That may relate to management assessment of risk, capital required to support rating agency opinions, capital assessment of policyholders, and the like. Increasing RBC may trigger unintended increases in the required capital assessment by those other stakeholders.

Potential Considerations for Increasing the Safety Level from 87.5%

1. The original targeted risk level was 90%, higher than 87.5%, which is now in place.

2. The risk level in the past was effectively higher than the 87.5%, the intended calibration target, because of calibration features, including:

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[66] We have not evaluated the equivalent one-year safety levels in this Report.

[67] Casualty Actuarial Society (CAS) Risk-Based Capital Dependencies and Calibration Working Party: Report 6: "Risk-Based Capital (RBC) Premium Risk Charges—Improvements to Current Calibration Method," CAS E-Forum Fall 2013; Report 7: "Risk-Based Capital (RBC) Reserve Risk Charges—Improvements to Current Calibration Method," CAS E-Forum Winter 2014; Report 11: "Risk-Based Capital (RBC) Underwriting Risk Factor Safety," CAS E-Forum Winter 2016.

- For reserve risk, payment patterns on LOBs with substantial unpaid losses at 10 years may have been conservative, i.e., underestimating the reduction due to investment income and therefore overestimating the risk charges.
- There was a downward trend in indicated undiscounted risk factors This downward trend may not continue.

3. The calibration in this Report does not include the years before 1988. Using those years in our calibration might over-represent the risk of a similar eight-year period in the total 38-year experience period. However, those may deserve some recognition. Using a higher overall safety level would acknowledge that experience and the possibility of its reoccurrence, albeit for different reasons.

10. CALCULATION OF LINE 4 AND IIA RISK FACTORS

Table 10.1 shows the calculation of indicated Line 4 and IIA factors from PV indicated risk charges. We use A-HO and F2-MPL-C as examples.

Table 10.1
Sample Calculation of Line 4 and Line 7/8 Factors

Row	Step	LOB			
		Premium Risk		Reserve Risk	
		A-HO	F2-MPL-C	A-HO	F2-MPL-C
A. Indicated Line 4 and IIA Factors					
1	Indicated Risk Charge-PV Approach; Gross of Cat; Including risk development horizon and WC tabular adjustments (Appendix 5 Exhibit A5-1A, 1B, col 7).	21.3%	24.4%	16.6%	-0.9%
2	Expense Ratio (Table 1.1A, column 2)	28.9%	25.5%	NA	NA
3	IIAs- 40-year runoff payment pattern; 4% interest; (Exhibit A2-5A and 5B; Also Table 1.1)	0.966	0.863	0.951	0.896
4	Indicated Line 4 Factor Gross of Cat Prem: (4) = (1.0+(1)-(2))/(3) Reserve: (4)=(1.0+(1))/(3)-1.0	0.956	1.146	22.6%	10.6%
5	Indicated Catastrophe Adjustment (Table 7.1, column 6)	2.6%	NA	NA	NA
6	Indicated Line 4 Factor Net of Cat (6)=(4)-(5)	0.930	1.146	0.226	0.106
B. Illustration of Minimum Risk Charges					
7	Indicated Risk Charge Net of Cat Prem: (6)*(3)+(2)-1.0 Reserve: (1.0+(6))*(3)-1.0	18.8%	24.4%	16.6%	-0.9%
8	Max of 5.0% and row (7)	18.8%	24.4%	16.6%	5.0%
9	Indicated Line 4 Factor Net of Cat, after minimum Prem: (9) = (1.0+(8)-(2))/(3) Reserve: (9)=(1.0+(8))/(3)-1.0	0.930	1.146	22.6%	17.2%
C. Illustration of application of transition rules with maximum changes					
10	2022 Risk Factor, net of cats (Table 1.1 column 2)	0.936	1.130	0.213	0.276
11	2022 IIA (Table 1.1)	0.954	0.827	0.938	0.883
12	2022 Risk Charge (Net of Cats) Prem: (10)*(11)+(2)-1.0 Reserve: (1.0+(10))*(11)-1.0	18.2%	18.9%	13.8%	12.7%
13	Indicated change in risk charge (net of cats) (12)/(7)-100%	3.2%	29.0%	20.4%	-106.9%
14	Line 13 subject to Maximum increase 10.0% Maximum decrease -10.0%	3.2%	10.0%	10.0%	-10.0%
15	Indicated risk charge after transition limitations; subject to 5% minimum Max((1.0+(14))*(12), 5%)	18.8%	20.8%	15.2%	11.4%
16	Indicated Line 4 Factor Net of Cat After Transition Caps and Minimum Prem: (1.0+(15)-(2))/(3) Reserve: (1.0+(15))/(3)-1.0	0.930	1.105	0.211	0.243

The calculations in Table 10.1 are as follows:

Part A—Indicated Line 4 and IIA Factors

Row 1: Indicated risk charge from Appendix 5, Exhibit A5-1A and 1B, column 7, for premium risk and reserve risk, respectively. These are the PV indicated risk charges, gross of catastrophe adjustments, based on an 87.5th percentile safety level, including the RDHA.

Row 2: Expense Ratio—The industry 2017 average expense ratio by LOB. We use row 2 to convert the premium risk charge to a premium risk factor in row 4.[68]

Row 3: Investment Income Adjustments—Indicated Line 7/8 factors, from Appendix 2, Exhibit A2-5A and 5B, row labeled "Disc at 4.0%," based on the 40-year runoff payment pattern[69] by LOB and a 4% interest rate. These are also the indicated IIAs in Table 1.1.

Row 4: Indicated Line 4 factors before catastrophe adjustment and before applying minimum risk charges or caps due to transition rules. We calculate row 4 with the formulas shown. These formulas reverse how we calculate risk charges, shown in the notes to Table 1.1.

The PV indicated risk charges in row 1 are independent of the interest rate used to calculate IIAs. If the interest were higher, the IIAs would be lower, but the indicated risk factors would be higher by an offsetting amount.

Row 5: Indicated catastrophe adjustment from Table 7.1, column 6.

Row 6: Indicated Line 4 Factor net of catastrophe adjustment. Row 6 is the value to be used in the RBC Formula, absent the application of minimums and transition rules.

Part B: Minimum Risk Charges

The NAIC Working Group generally applies a minimum risk charge. Rows 7-9 illustrate how we calculate the Line 4 factor when applying a 5% minimum risk charge.

Row 7: Risk charge net of catastrophes. The minimum applies to the risk charge after catastrophe adjustment. In row 7, we express the indicated Line 4 factor net of catastrophe adjustment (row 6) as a risk charge. We do this by applying the risk charge formula we show the Notes to Table 1.1 to row 6, the indicated Line 4 risk factor net of the indicated catastrophe adjustment.

For a LOB with no catastrophe adjustment, row 7 = row 1.

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[68] The LOB expense ratio in this step must be consistent with the expense ratio we use to develop indicated risk charges.

[69] We use the 40-year runoff payment pattern rather than the 40-year truncated payment pattern. We use the 40-year truncated payment pattern to put the RDHA into the overall risk charge. However, the runoff payment pattern better presents the actual investment income potential. Using the runoff payment pattern for IIAs makes the risk factors higher than they would be with the truncated payment pattern. That is correct because the RDHA is an increase in the risk factor.

Row 8: Indicated risk charge equals the maximum of the indicated risk charge from row 7, or the selected minimum, 5% in this example.

Row 9: Converts the risk charge in row 8 to the Line 4 risk factor using the formulas in row 4, starting from row 8 rather than row 1. For any LOB with a risk charge already 5.0% or greater, row 9 = row 6.

Part C: Transition rules (Maximum and Minimum Changes in Risk Charges)

The Working Group has generally applied maximum increases/decreases to annual changes in risk charges. Rows 10-16 illustrate how we calculate the Line 4 factor when applying a maximum increase/decrease in risk charge.

Row 10, 11: The maximum/minimum change in risk charge is measured against the current risk charge. Rows 10 and 11 show the RBC Formula Line 4 and Line 7/8 IIA factors, respectively.

Row 12: We calculate the risk charge implied by the 2022 Line 4 and Line 7/8 IIA factors. The formula is the same as row 7, using rows 10 and 11 instead of rows 6 and 3, respectively.

Row 13: The change in risk charge from the 2022 risk charge (row 12) to the indicated risk charge (row 13) = (row 12) / (row 7)) -100%.

Row 14: Row 13 limited to reflect the selected transition maximum increase (10% in this example) and the selected maximum decrease (-10% in this example).

Row 15: Indicated risk charge after transition caps and minimum risk charge. Row 15 equals 1.0 + row 14, times row 12, but at least as large as the minimum risk charge, 5% in the example.

Row 16: Line 4 factor after transition caps and minimum risk charge. We calculate this using the formula on row 4, using row 15 instead of row 1.[70]

For the 90th and 95th percentile safety levels, Line 1 would be the 90th or 95th percentile PV indicated risk charge, and Line 5 would be the indicated catastrophe adjustment at the corresponding safety level. In other respects, the calculations are the same.

[70] We thereby apply the limit via the risk factor rather than the IIA.

11. AREAS OF FUTURE RESEARCH RELATED TO UNDERWRITING RISK

This Report analyzes a variety of key parameters in the RBC Formula. We observe the following underwriting risk areas that might warrant review in future work.

General P&C RBC UW Research Areas

- Examine premium and reserve risk variation with LOB diversification. The Academy is preparing a review of the diversification formula (PR017/018, Line 14).
- Analyze the correlation between premium risk and reserve risk. The RBC Formula assumes those two risks are independent.
- Examine the performance of catastrophe models against catastrophe experience.
- Assess the growth charge. The current growth risk charge was calibrated in the 1990s, and the calibration has not been reviewed.
- Review the variation in indicated risk factors by company size or LOB size. When RBC was developed, an Academy Committee developed a method to consider company size. The NAIC did not adopt the proposal.
- From time to time, examine the extent to which LOBs currently consolidated in the RBC Formula should be examined separately, e.g., the occurrence and claims made LOBs for OL and PL, and property non-proportional reinsurance and financial non-proportional reinsurance.
- Examine the extent to which the own-company adjustment calculation (Lines 1-3) is supported by experience. This calculation has not been evaluated since it was implemented in the original RBC Formula.
- Review the variability of WC tabular discount among companies and the extent to which that affects the comparability of TAC among companies. Consider extending the scope of PR038, which includes certain medical tabular discount information, to all areas of discount.
- Assess the extent of the tabular reserve impact on RBC for LOBs other than D-WC.

Research Areas Related to Calibration in This Report

- Monitor the extent to which the relationship between risk factors and interest rates continues, i.e., the validity of the PV Method.
- Examine the extent to which risk charges vary based on changes in interest rates rather than the current level of interest rates.
- Assess possibilities for better quantification of the RDHA.
- Assess possibilities for using data excluding catastrophes to examine risk factors, dependency, payment patterns, etc. That is only possible through RBC data, which is logistically challenging because of data confidentiality.
- Reserve IIAs are sensitive to the proportion of reserves by AY. Particularly for LOBs with a large amount of long-tail business, reserve IIAs for both new and runoff

companies may imply too much investment income, producing understated risk charges. Assess the extent to which that might be significant.

- Explore the stability of the "empirical" risk charge calibration for such safety levels if safety levels as high as the 95th percentile were to be used.
- Analyze payment pattern risk.
- Evaluate the extent to which variation in LRs/RRRs over time can be associated with particular historical events, economic conditions, etc., to better provide a basis for risk charge calibration.
- Evaluate the impact of having excluded A&O payments for selected payment patterns.

12. APPENDIX 1—2010 Payment Pattern Method

In this Appendix, we describe the method of determining IIAs that we refer to as the 2010 Method. This discussion assumes the reader is familiar with the construction of payment patterns from Annual Statement data.

Exhibit A1-1 shows the calibration with the 2010 Method using 2017 data and H-OL coverage as an example. The calculations in Exhibit A1-1 are as follows:

- Columns 3 and 4 are the incurred loss and LAE and the cumulative paid loss and LAE from the industry total 2017 Annual Statement Schedule P Part 1.
- Column 5 shows the AY cumulative paid loss and LAE as a percentage of the company incurred loss and LAE for that AY, column 4 divided by column 3.
- Column 6, for ages 1-10, shows the year-to-year differences between the values in column 5. Column 6 is the payment pattern through age 10; e.g., the age 6 value in column 6 is 7.16% which equals 77.92%-70.76%.
- For column 6, ages 11 and over:
    - Column 5 shows that at age 10, AY 2008, only 92.17% of the ultimate loss has been paid.
    - Thus, the unpaid portion is 7.83%, i.e., 100% minus 92.17% =7.83%.
    - The method assumes that the year 10 value, 1.83%, will be the paid percentage for years 11 and over until the total unpaid is exhausted.

  For many LOBs, determining the loss percentages in column 6 for ages 11 and over is straightforward, as is the case for H-OL. For some LOBs, judgment is required to constrain the pattern to 15 years and remain consistent with payment rates for years leading to year 10.
- Column 7 shows the discount factors at 5% per year. The discounting time period for age 1 is 0.5 years, the discounting time period for age 2 is 1.5 years, etc.

  Column 7, row “Prem IIA,” shows the indicated premium IIA, 0.825. That value is the weighted average of column 7 discount factors and column 6 incremental paid percentages.

- Column 8 shows reserve discount factors for AY reserves at the ages in column 2.

  For each age in column 8, e.g., age n, the calculation is (a) the column 6 payment percentages by age for ages n+1 and higher, times (b) the AY discount factors from column 7 for ages 1 through 15-n,[71] divided by (c) the sum of column 5 payment percentages for ages n+1 and higher.

  The column 8 calculation takes the unpaid portion of losses from each AY for each age and discounts that back to the initial age.

- Column 9 shows the 2017 reserve by AY. The reserve IIA, 0.860, is the weighted average of the reserve discount factors in column 8 using weights in column 9, the 2017 reserve by AY.

  Note that column 9 does not include the prior year reserve, $23.8 million, [72]that is not used in calculating premium or reserve IIAs.

For Two-Year LOBs, the method is the same, using only ages 1 and 2.

[71] For example, the age 8 reserve discount factor, .866, is as follows:
(0.0237*0.976+0.0183*0.929+0.0183*0.885+0.0183*0.843+0.0183*0.803+0.0183* 0.765+0.0052*0.728)/
(.0237+.0183+.0183+.0183+.0183+.0183+.0052)

[72] Exhibit A2-3.

Exhibit A1-1
2010 Payment Pattern Method—2017 Experience: LOB H-OL

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
AY	Age (Yrs)	Total Incurred ($millions)	Cumulative Paid ($millions)	Cumulative Paid % (4)/(3)	Incremental Paid % (4)n+1-(4)n	Discount Factor (1.05)^((2)-.5)	Reserve Discount Factor	Outstanding Reserve ($millions)
2003	15				0.52%	49.3%		
2004	14				1.83%	51.8%		
2005	13				1.83%	54.3%		
2006	12				1.83%	57.1%		
2007	11				1.83%	59.9%	92.2%	
2008	10	27,868	25,687	92.17%	1.83%	62.9%	90.1%	2,181
2009	9	27,375	24,732	90.35%	2.37%	66.1%	88.1%	2,643
2010	8	26,344	23,177	87.98%	3.49%	69.4%	86.6%	3,167
2011	7	27,557	23,283	84.49%	6.57%	72.8%	85.9%	4,275
2012	6	28,160	21,941	77.92%	7.16%	76.5%	86.5%	6,219
2013	5	28,172	19,934	70.76%	10.53%	80.3%	86.1%	8,238
2014	4	30,132	18,149	60.23%	15.45%	84.3%	86.1%	11,984
2015	3	31,130	13,941	44.78%	18.10%	88.5%	86.4%	17,189
2016	2	32,200	8,591	26.68%	17.11%	92.9%	86.0%	23,609
2017	1	31,697	3,035	9.57%	9.57%	97.6%	84.9%	28,662
Total		290,636	182,470		100.00%			108,166
					Prem IIA=	82.5%		
					Res IIA =		86.0%	

The 2010 Method is like the method used by the NAIC in calibrating the IIAs in the original RBC Formula in 1996. To our knowledge, this method has been used in Academy reviews before 2010.

13. APPENDIX 2—40-year Runoff Payment Pattern Methods

This Appendix describes how we calculate the 40-year runoff payment pattern. This discussion assumes the reader is familiar with the construction of payment patterns from Annual Statement data. In this discussion, the terms 'loss,' 'paid,' 'unpaid,' and 'reserves' refer to amounts of loss and DCCE combined. Exhibits A2-1 through A2-4 show our calculations. Exhibits A2-5A and A2-5B show the resulting payment patterns by LOB for premium and reserves, respectively.

Overview

In summary, our method is as follows:

1. Determine AY Payment Patterns

   For Ten-Year LOBs:

   - Construct a paid loss development "triangle" and paid loss development factors (LDFs) for Loss and DCCE from the industry total 2017 Annual Statement Schedule P Part 3. The development triangle contains up to 10 calendar years of paid loss development for each AY and LOB. (Exhibit A2-1)
   - Calculate the ratio equal to paid loss at age 10 divided by reported ultimate incurred loss at age 10, using the 2013-2017 Annual Statement Parts 2 and 3. This ratio is our estimate of the expected payments beyond 10 years. Exhibit A2-2A column 2 shows the expected payments beyond 10 years by LOB.
   - Assume an exponential decay of remaining unpaid losses beyond year 10. Select the decay rate for ages 10 and over, using the decay rate observed from age 9 to age 10. Allow payments to extend to year 40. Exhibit A2-2A, column 3 shows the selected decay rate by LOB.

     Exhibit A2-2B shows the application of the decay ratio method to D-WC and A-HO. D-WC has the longest payment pattern, and A-HO has a much shorter payment pattern.

   For Two-Year LOBs:

   - For Two-Year LOBs other than T-Wrnty, apply the method outlined above but use payment triangles and reported ultimate incurred loss from RBC Filings. The RBC data gives paid and incurred loss development extending to 10 years.[73]

[73] For Two-Year LOBs, the Annual Statement information provides only two years of paid development. The 10-year payment triangles for Two-Year LOBs were prepared by regulators who constructed aggregated blinded summary data for use by this Committee. As a quality control feature, we also had the regulators exclude data when there were any "gaps" in paid or incurred loss data triangle. We also had the regulators exclude data from companies with unexpectedly large year-to-year movements in paid losses within an AY, as that might relate to data issues.

- For T-Wrnty, use the two years of payments available from the Annual Statements, as the RBC data is not sufficiently reliable.[74]

2. Calculate Reserves by AY (Exhibit A2-3 and A2-4)
   - The 2017 Annual Statements provides the reserves by AY for AY ages 1-10, separately, and the prior reserves, AY ages 11-ultimate, for all AYs combined.
   - For ages 11-40, we estimate the proportion of the prior reserves in each AY at ages 11-40, assuming equal levels of incurred loss by AY[75] and reducing the incurred by the paid portion estimated using the AY payment pattern.
3. Project Payments by Calendar Year (Exhibit A2-3 and A2-4)
   - For each AY within the reserve, ages 2[76] and over, project future payments by calendar year using the year-by-year portions of each AY's payment pattern.
   - Combine the calendar year payments by AY into the overall reserve payment pattern.

Sample Calculations

We use D-WC in the attached Exhibits to illustrate the method. The method is the same for all Ten-Year LOBs.

We first discuss the AY payment patterns we use for premium IIAs. Then we discuss reserve year payment patterns used for reserve IIAs.

Exhibit A2-1: AY Payment Pattern for Premium IIAs—Ages 1-10

The upper portion of this Exhibit shows the P&C industry total December 31, 2017, Schedule P Part 3, for D-WC.

The middle portion shows the age-to-age paid LDFs for ages 1:2 to 9:10. Below those factors, we show five types of average paid LDFs. The bottom section of the Exhibit shows the selected age-to-age LDFs. When three years of data are available, we select the three-year-weighted average age-to-age LDF. We use shorter-term averages when three years are not available. Note that this

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[74] T-Wrnty was included in K-Fid/Sur for RBC purposes until 2008. The transition from K-Fid/Sur to a standalone T-Wrnty was implemented by AY, so the 2017 RBC Filing was the first to include a complete set of AYs. However, we conclude that the 2017 RBC data was not sufficiently reliable, and we use the Schedule P data instead.

[75] If we assume that incurred losses in later years were lower, then there would be more reserves for "younger" AYs (say, with ages 11-20) and less reserves for "older" AYs (say with ages 30-40). The investment income credit for years near age 11 is larger than the investment income credit for later. Therefore, assuming constant incurred loss in past years yields somewhat higher IIAs, i.e., less investment income, than assuming incurred losses in later years are smaller.

New companies and runoff companies will have reserves for a limited number of AYs. Depending on the ages of the reserves for those companies, they will tend to have less future investment income than an ongoing company with a full set of AYs.

[76] Payments in year 1 have occurred prior to the initial reserve evaluation date, e.g., paid in 1988 for reserve date December 31, 1988. Hence, year 1 payments do not affect the reserve IIAs.

revised method uses data from multiple calendar years, i.e., multiple diagonals. In contrast, the 2010 Method, in effect, uses only one diagonal of data, to select age-to-age factors.

Schedule P does not contain year-to-year development for ages 10 and over. Therefore, for the total development from age 10-to-ultimate, we use the ratio of reported ultimate incurred to the paid-to-date at age 10. We select the average 10:ultimate ratio from five Annual Statements, 2013-2017.

In the bottom-most section of the Exhibit, we use the age-to-age factors 1:2 through 9:10 and the 10:ultimate LDFs and calculate the cumulative LDF ("Selected Cumulative"). The cumulative percentage paid-to-date is the reciprocal of the cumulative development factor ("Cumulative % Paid"). The annual percentages paid ("Incremental %Paid" and "Selected Incr % Paid") are the differences between the cumulative percentages paid from age to age. For ages 1 through 10, the row Selected Incr % Paid is the percentage paid by year in Exhibit A2-5A.

Exhibit A2-2A and 2B: AY Payment Pattern for Premium IIAs—Ages 11-40

Most LOBs have some reserves at age 10. The amount is substantial for lines with longer payment patterns, particularly D-WC. Exhibit A2-2A column 2 shows the expected percentage of AY losses unpaid at age 10 based on the selected payment pattern, for each LOB. D-WC, O-Re-Liab, and R-PL are the LOBs with the largest proportion of expected unpaid loss at age 10.

We use a "decay ratio" to estimate annual payments on reserve amounts after age 10. For D-WC, we select a decay ratio of 90%. The 90% decay ratio means that at any age, 90% of the prior year reserve remains unpaid at the subsequent year-end, and 10% will be paid in the subsequent year. For example, if there were $1000 in reserves at age 10, we would project $100 paid in year 11—leaving $900 unpaid; $90 paid in year 12—leaving $810, $81 paid in year 13—leaving $729 unpaid, etc. Exhibit A2-2A column 3 shows the decay ratios by LOB.[77] Exhibit A2-2B shows the application of the decay ratio method to D-WC and A-HO. D-WC has the longest payment pattern, and HO has a much shorter payment pattern.

To select the decay ratio in this Exhibit, we examine the decay ratios at ages 7, 8, and 9, i.e., the paid in year 8 divided by reserves at age 7, the paid in year 9 divided by the reserves at year 8, and the paid in year 10 divided by the reserves at year 9. The decay ratios are generally higher (less paid in the next year) as age increases from 7 to 8 and 9. Therefore we selected the decay ratio based on the observed decay ratio from 9 to 10,[78] the most mature AY.

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[77] Because RBC Filings do not contain prior-year reserves, for the Two-Year LOBs where we use RBC data, we assume that the unpaid at year 10 is zero for those LOBs.

[78] The decay ratio significantly affects the resulting payment patterns and IIAs, particularly for longer tail LOBs. We do not believe we have overstated that discount for two reasons. First, we use the decay ratio for ages 9 to 10. The decay ratio for 9 to 10 is higher (implying longer payment patterns) than the decay ratio for ages 8 to 9 and 7 to 8. We take that to mean the decay ratios for 11 and older will more likely be higher still (implying longer payment patterns) than the decay ratio we used. Also, the exponential decay that we use is one pattern sometimes used for payment patterns, but other commonly used methods are slower than exponential.

We limit the payment period to 40 years. For most LOBs, although not D-WC, there is essentially zero expected paid by 40 years. To the extent that there are expected payments beyond 40 years, we normalize the payment pattern so that the total paid within 40 years is 100%.

Exhibit A2-5A shows the AY payment patterns for ages 1-40 by LOB. For our D-WC example, for ages 1 through 10, the values equal the row "Selected Incr % Paid." For ages 11 and over, the values equal Exhibit A2-2B, column 3.

Exhibits A2-3 and A2-4: Reserve Year Payment Pattern for Reserve IIAs

In Exhibits A2-3 and A2-4, we determine the payment pattern for reserve IIAs. We use the AY payment patterns determined above and the distribution of December 31, 2017, reserves by AY.

The upper portion of Exhibit A2-3 shows the reserves by AY for the latest 10 AYs and for all prior AYs combined, for Ten-Year LOBs. The lower portion of Exhibit A2-3 shows the same information for Two-Year LOBs.

For the Ten-Year LOBs, we obtain the data by AY from the December 31, 2017, industry total Schedule P, Part 1. For these Two-Year LOBs, we obtain the data for AYs 2017 and 2016 from the industry Schedule P, and we use RBC data to allocate the prior year annual statement reserve to the oldest eight AYs.

The top of Exhibit A2-4, on the row called 'Remaining Reserve," shows the reserves by AY. For ages 1-10, the values by AY are from Schedule P Part 1, as shown in Exhibit A2-3. For ages 11 and over, we allocate the total prior reserve, from Exhibit A2-3, into the reserves by AY. To do so, we assume that each AY, for ages 11 and over, has the same incurred loss amount, and we use the AY payment patterns to determine the expected reserves for each AY at ages 11 and over.[79] Finally, we normalize the sum of those values to match the observed total reserve for ages 11 and over.

For each AY component of the reserve, i.e., each column in Exhibit A2-4, we use the AY payment pattern to project the payment of that reserve by calendar year, i.e., down the rows of Exhibit A2-4. For example, we project that the reserves at age 1 will have payments that follow the portion of the expected AY payments from year 2 to year 40. The AY expected payment is from Exhibit A2-5A. For age 2, we project that the reserves at age 2 will have calendar year payments that follow the expected AY payments from year 3 to year 40, etc.

Using the payments by age and by AY, the right side of Exhibit A2-4 shows the total paid amount by calendar year and the percentage paid by calendar year. That column, labeled "% of Total," is the indicated reserve year payment pattern shown in Exhibit A2-5B.

[79] See footnote 75 for a discussion of this assumption.

Two-Year LOBs

We apply the method outlined above for Two-Year LOBs other than T-Wrnty, but we use paid and incurred loss data from RBC Filings. The RBC data gives paid and incurred loss development extending to 10 years.[80]

RBC data has situations where companies do not complete the entire data triangle (zero-interior triangles). Therefore, we include only companies with complete non-zero triangles. We also exclude companies with unexpectedly high development factors, as such development factors might relate to data issues.

There is no prior year reserve for Two-Year LOBs in the RBC data, so we assume these are zero for AYs after age 10. For reserve payment patterns, we determine reserves by AY using Annual Statement Part 1 loss and LAE reserves for ages 1 and 2 and allocating the prior row (ages 3 and over) in proportion to the RBC reserves by AY.[81]

For T-Wrnty, we use the 2-years available from Annual Statements, as there is insufficient RBC data.

Exhibits A2-5A and 5B: Payment Patterns by LOB

Exhibits A2-5A and 5B show the resulting payment patterns, by LOB, for premium risk and reserve risk, respectively.

The last rows in these exhibits show the IIA based on the payment patterns and interest rates of 3%, 4%, and 5%.

[80] This data is confidential, so regulators aggregated and blinded the information before providing it to us.

[81] With judgmental adjustments for S-FG/MG and T-Wrnty.

Exhibit A2-1
Premium—D-WC: Payment Pattern by LOB—40-Year Runoff Method

ANNUAL STATEMENT FOR THE December 31, 2017 OF THE P&C Industry

SCHEDULE P - PART 3 - Workers' Compensation

		1	2	3	4	5	6	7	8	9	10	11	12
Years		CUMULATIVE PAID NET LOSSES AND DEFENSE AND COST CONTAINMENT EXPENSES REPORTED AT YEAR END ($000 OMITTED)										Number of	Number of
in Which Losses Were		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Claims Closed With Loss	Claims Closed Without Loss
Incurred												Payment	Payment
1	Prior	0	16,338,485	25,717,362	33,284,563	39,837,469	46,285,914	50,957,924	55,285,931	58,998,074	62,804,847	12,058,134	2,247,696
2	2008	5,767,240	12,476,354	16,421,458	18,939,529	20,684,967	21,951,372	22,888,114	23,554,426	24,144,736	24,696,145	3,111,523	855,943
3	2009	XXX	5,239,687	11,364,656	14,929,131	17,199,433	18,872,313	20,032,134	20,798,322	21,456,335	22,076,041	2,714,959	756,653
4	2010	XXX	XXX	5,366,813	11,690,663	15,434,313	17,856,036	19,509,235	20,505,120	21,375,253	22,137,598	2,747,481	749,259
5	2011	XXX	XXX	XXX	5,537,365	11,926,436	15,750,451	18,150,554	19,733,210	20,932,857	21,930,217	2,760,213	765,604
6	2012	XXX	XXX	XXX	XXX	5,416,142	11,769,257	15,324,766	17,552,686	19,172,205	20,350,437	2,696,612	754,795
7	2013	XXX	XXX	XXX	XXX	XXX	5,263,081	11,510,043	15,100,434	17,482,509	19,074,499	2,613,024	718,071
8	2014	XXX	XXX	XXX	XXX	XXX	XXX	5,304,264	11,580,530	15,360,325	17,740,648	2,593,134	722,560
9	2015	XXX	XXX	XXX	XXX	XXX	XXX	XXX	5,149,257	11,675,824	15,490,331	2,505,148	725,937
10	2016	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	5,183,318	11,314,727	2,264,318	702,493
11	2017	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	5,146,959	1,409,364	557,803
		1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-ult		
	2008	2.163	1.316	1.153	1.092	1.061	1.043	1.029	1.025	1.023			
	2009	2.169	1.314	1.152	1.097	1.061	1.038	1.032	1.029				
	2010	2.178	1.320	1.157	1.093	1.051	1.042	1.036					
	2011	2.154	1.321	1.152	1.087	1.061	1.048						
	2012	2.173	1.302	1.145	1.092	1.061							
	2013	2.187	1.312	1.158	1.091								
	2014	2.183	1.326	1.155									
	2015	2.267	1.327										
	2016	2.183											
	Average	2.184	1.317	1.153	1.092	1.059	1.043	1.032	1.027	1.023			
	5-yr avg	2.199	1.318	1.153	1.092	1.059							
	3-yr avg	2.211	1.322	1.153	1.090	1.058	1.043	1.032					
	Wtd Avg	2.184	1.317	1.153	1.092	1.059							
	5-yr wtd	2.198	1.318	1.153	1.092	1.059							
	3-yr wtd	2.211	1.322	1.153	1.090	1.058	1.043	1.032					
		1	2	3	4	5	6	7	8	9	10	11-40	
Selected age to age		2.211	1.322	1.153	1.090	1.058	1.043	1.032	1.027	1.023	1.207		
Selected Cumulative		5.298	2.396	1.813	1.573	1.443	1.364	1.308	1.267	1.234	1.207		
Cumulative % Paid		**18.9%**	**41.7%**	**55.2%**	**63.6%**	**69.3%**	**73.3%**	**76.4%**	**78.9%**	**81.0%**	**82.9%**	**100.0%**	
Incremental % Paid		**18.9%**	**22.9%**	**13.4%**	**8.4%**	**5.7%**	**4.0%**	**3.1%**	**2.5%**	**2.1%**	**1.9%**	**17.1%**	
Selected Incr % Paid		**18.87%**	**22.86%**	**13.42%**	**8.42%**	**5.73%**	**4.00%**	**3.14%**	**2.45%**	**2.13%**	**1.85%**	**17.13%**	

Exhibit A2-2A
Inputs To Calculation of Payment Patterns 10 to Ultimate

(1)	(2)	(3)
LOB	Unpaid at Year 10	Decay Ratio
A-HO	0.16%	80%
B-PPA	0.43%	80%
C-CA	0.79%	80%
D-WC	17.13%	90%
E-CMP	2.43%	80%
F1-MPL-O	11.05%	80%
F2-MPL-C	3.79%	80%
G-SL	1.90%	90%
H-OL	9.12%	80%
M-Intl	2.98%	90%
N-Re-Prop	2.38%	80%
O-Re-Liab	16.49%	90%
R-PL	15.49%	80%

Exhibit A2-2B
Example Calculation of Payment Pattern from Decay Ratio

	WC		HO	
		(3) = 17.13%*		(5) = 0.16%*
(1)	(2)	[(2) / TOTAL(2)]	(4)	[(4) / TOTAL(4)]
Year	**% Unpaid**	**% Paid**	**% Unpaid**	**% Paid**
11	90%	1.79%	80%	0.04%
12	81%	1.61%	64%	0.03%
13	73%	1.45%	51%	0.02%
14	66%	1.30%	41%	0.02%
15	59%	1.17%	33%	0.01%
16	53%	1.06%	26%	0.01%
17	48%	0.95%	21%	0.01%
18	43%	0.86%	17%	0.01%
19	39%	0.77%	13%	0.01%
20	35%	0.69%	11%	0.00%
21	31%	0.62%		
⋮	⋮	⋮	⋮	⋮
31	11%	0.22%	0%	0.00%
32	10%	0.20%	0%	0.00%
33	9%	0.18%	0%	0.00%
34	8%	0.16%	0%	0.00%
35	7%	0.14%	0%	0.00%
36	6%	0.13%	0%	0.00%
37	6%	0.12%	0%	0.00%
38	5%	0.10%	0%	0.00%
39	5%	0.09%	0%	0.00%
40	4%	0.08%	0%	0.00%
		17.13%		0.16%

*From Exhibit A2-2A

Exhibit A2-3
Reserves by AY for Reserve Payment Pattern Calculations

Ten-Year LOBs

Years in Which Losses Were Incurred	A	B	C	D	E	F1	F2	G	H	M	N+P	O	R
Prior	462,087	3,607,422	683,450	46,730,063	3,338,253	601,136	458,858	632,594	23,819,514	58,699	441,965	13,056,924	7,235,955
2008	57,901	403,379	73,892	4,754,173	393,723	164,663	126,414	91,423	2,181,441	714	43,723	593,636	262,508
2009	82,916	530,069	114,661	4,531,090	468,160	264,503	195,055	66,837	2,643,004	1,928	51,133	760,703	263,732
2010	120,288	756,211	171,662	4,945,290	650,450	364,234	323,950	54,827	3,166,627	465	115,678	805,282	337,233
2011	179,958	1,055,332	334,403	5,801,023	973,796	579,190	510,435	112,357	4,274,613	1,440	254,281	1,184,837	399,283
2012	289,091	1,708,858	677,925	6,863,969	1,366,738	780,770	794,028	179,480	6,218,933	1,011	326,089	1,515,897	506,616
2013	481,557	3,145,374	1,381,432	8,319,155	2,339,715	1,092,576	1,269,826	300,193	8,237,914	3,508	438,722	1,587,338	648,556
2014	962,878	6,776,965	2,838,543	10,398,702	3,571,969	1,439,589	1,977,657	404,812	11,983,609	5,138	514,554	1,919,723	928,651
2015	1,899,624	14,017,102	5,387,328	13,552,363	5,484,267	1,682,944	2,824,304	623,797	17,188,553	7,510	1,168,659	2,149,401	1,270,343
2016	3,932,790	28,008,470	8,755,111	18,689,579	7,950,397	1,836,257	3,891,886	1,007,692	23,608,705	23,356	2,169,086	2,570,879	1,466,552
2017	19,002,341	63,021,207	13,198,633	26,379,724	14,634,965	1,911,060	4,713,886	2,051,554	28,662,366	172,808	6,246,671	4,318,944	1,691,732
Total	27,471,431	123,030,389	33,617,040	150,965,131	41,172,433	10,716,922	17,086,299	5,525,566	131,985,279	276,577	11,770,561	30,463,564	15,011,161
Prior + 2008 as % Total	1.7%	2.9%	2.0%	31.0%	8.1%	5.6%	2.7%	11.4%	18.0%	21.2%	3.8%	42.9%	48.2%

Two-Year LOBs

Years in Which Losses Were Incurred	I	J	K	L	S	T
Prior	0	0	0	0	0	0
2008	72,567	18,418	42,549	75,945	12	847
2009	28,784	9,436	139,278	86,392	37	1,129
2010	126,946	11,784	99,728	131,855	10	1,505
2011	425,657	7,795	90,521	230,058	60	2,007
2012	180,656	20,266	48,598	249,092	378	2,676
2013	166,490	5,480	297,562	351,683	443	3,568
2014	462,770	68,432	381,397	551,038	12,477	4,757
2015	1,227,880	226,315	775,154	899,054	22,499	6,343
2016	2,792,048	217,882	955,883	1,224,401	72,591	7,287
2017	17,185,871	7,148,311	1,424,068	3,696,189	127,353	82,252
Total	22,669,669	7,734,119	4,254,739	7,495,707	235,860	112,369

Notes:

For Two-Year LOBs, I-SP, J-APD, K-Fid/Sur, and L-Other, Total AY 2016 and AY 2017 reserves are from the Annual Statement. For AYs 2015 and earlier, we distributed the AY 2015 and prior year total reserve from the Annual Statement to AY based on RBC data.

For S-FG/MG: Used RBC data for AY 2016 and prior; AY 2017 judgmentally selected.

For T-Wrnty: Total reserve is from the 2017 Annual Statement; AY 2015 and prior year reserve is judgmentally spread to AY.

Exhibit A2-4
D-WC: Reserve Risk Payment Pattern
(Amounts in Millions)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)		(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)		
Row #	Year	Pattern Pattern	Discount Factor @5.0%	Reserve for Year at the maturity (month): Amounts in Millions																						
1	**Remaining Reserve:**			26,380	18,690	13,552	10,399	8,319	6,864	5,801	4,945	4,531	4,754	...	505	427	356	292	235	185	139	96	60	28		
2	**Maturity (yrs):**			1	2	3	4	5	6	7	8	9	10	...	30	31	32	33	34	35	36	37	38	39	TOTAL	% of Total
3.1	1	18.87%																								
3.2	2	22.86%	0.976	**7,433**	**4,304**	**2,544**	**1,636**	**1,084**	**807**	**603**	**499**	**442**	**497**	...	**78**	**71**	**64**	**57**	**50**	**46**	**43**	**36**	**32**	**28**	25,304	16.8%
3.3	3	13.42%	0.929	**4,364**	**2,701**	**1,731**	**1,142**	**851**	**630**	**524**	**433**	**427**	**447**	...	**71**	**64**	**57**	**50**	**46**	**43**	**36**	**32**	**28**		18,133	12.0%
3.4	4	8.42%	0.885	**2,738**	**1,838**	**1,209**	**896**	**664**	**548**	**456**	**419**	**384**	**402**	...	**64**	**57**	**50**	**46**	**43**	**36**	**32**	**28**			13,921	9.2%
3.5	5	5.73%	0.843	**1,863**	**1,283**	**949**	**699**	**577**	**476**	**441**	**377**	**346**	**361**	...	**57**	**50**	**46**	**43**	**36**	**32**	**28**				11,276	7.5%
3.6	6	4.00%	0.803	**1,301**	**1,007**	**740**	**608**	**501**	**460**	**396**	**340**	**310**	**325**	...	**50**	**46**	**43**	**36**	**32**	**28**					9,477	6.3%
3.7	7	3.14%	0.765	**1,021**	**786**	**644**	**528**	**485**	**414**	**357**	**305**	**279**	**294**	...	**46**	**43**	**36**	**32**	**28**						8,224	5.5%
3.8	8	2.45%	0.728	**797**	**683**	**559**	**511**	**436**	**373**	**320**	**274**	**253**	**264**	...	**43**	**36**	**32**	**28**							7,243	4.8%
3.9	9	2.13%	0.694	**693**	**593**	**541**	**460**	**393**	**334**	**288**	**248**	**227**	**239**	...	**36**	**32**	**28**								6,483	4.3%
3.10	10	1.85%	0.661	**602**	**574**	**486**	**414**	**352**	**301**	**261**	**223**	**205**	**214**	...	**32**	**28**									5,826	3.9%
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮												⋮	
3.30	30	0.24%	0.249	**78**	**71**	**60**	**51**	**43**	**36**	**32**	**28**	**24**	**25**												477	0.3%
3.31	31	0.22%	0.237	**72**	**64**	**54**	**46**	**38**	**33**	**30**	**23**	**21**	**22**												404	0.3%
3.32	32	0.20%	0.226	**65**	**58**	**48**	**40**	**35**	**31**	**25**	**21**	**19**													342	0.2%
3.33	33	0.18%	0.215	**59**	**51**	**42**	**37**	**33**	**26**	**22**	**19**														288	0.2%
3.34	34	0.16%	0.205	**52**	**45**	**39**	**34**	**27**	**23**	**20**															240	0.2%
3.35	35	0.14%	0.195	**46**	**42**	**36**	**29**	**24**	**21**																197	0.1%
3.36	36	0.13%	0.186	**42**	**38**	**30**	**26**	**22**																	158	0.1%
3.37	37	0.12%	0.177	**39**	**32**	**27**	**23**																		121	0.1%
3.38	38	0.10%	0.168	**33**	**29**	**24**																			86	0.1%
3.39	39	0.09%	0.160	**29**	**26**																				55	0.0%
3.40	40	0.08%	0.153	**26**																					26	0.0%
4	Disc Total	100.0%		21,122	14,364	10,054	7,510	5,894	4,818	4,053	3,461	3,182	3,358	...	417	358	303	252	207	166	127	90	58	28	150,965	100.0%
5	**Total Undiscounted**			150,965																						
6	**Total Discounted**			112,297																						
7	**Discount Factor**			**0.744**																						

Exhibit A2-5A
Premium: Payment Pattern by LOB—40-Year Runoff Method

Year	A-HO	B-PPA	C-CA	D-WC	E-CMP	F1-MPL-O	F2-MPL-C	G-SL	H-OL	I-SP	J-APD	K-Fid/Sur	L-Other	M-Intl	N-Re-Prop	O-Re-Liab	R-PL	S-FG/MG	T-Wrnty
1	73.14%	41.13%	18.94%	18.87%	41.63%	0.65%	4.66%	37.04%	6.81%	57.92%	96.50%	28.36%	61.07%	33.51%	27.10%	11.21%	4.77%	18.13%	84.13%
2	20.31%	30.07%	23.63%	22.86%	22.37%	3.74%	18.74%	32.60%	13.85%	31.94%	3.84%	39.86%	29.46%	35.05%	37.83%	11.63%	10.47%	32.22%	12.91%
3	3.53%	13.30%	20.88%	13.42%	11.09%	10.46%	23.82%	11.74%	16.69%	5.79%	-0.29%	15.94%	4.87%	14.91%	16.16%	16.50%	12.22%	19.97%	1.46%
4	1.44%	7.55%	16.64%	8.42%	9.61%	15.08%	17.71%	5.96%	15.89%	1.87%	-0.01%	3.63%	1.81%	8.19%	6.85%	12.11%	13.41%	8.03%	0.73%
5	0.67%	3.97%	10.27%	5.73%	5.62%	16.13%	12.53%	4.75%	12.43%	0.67%	0.02%	2.73%	0.74%	3.17%	3.25%	9.69%	12.70%	7.57%	0.37%
6	0.35%	1.79%	4.76%	4.00%	3.16%	15.23%	7.29%	2.15%	9.06%	0.61%	0.00%	2.28%	0.72%	1.50%	2.65%	8.20%	7.69%	5.73%	0.19%
7	0.19%	0.88%	2.22%	3.14%	1.85%	11.35%	4.14%	1.43%	5.82%	0.54%	-0.02%	1.50%	0.18%	0.26%	1.53%	5.32%	6.88%	1.09%	0.10%
8	0.11%	0.47%	1.05%	2.45%	1.08%	6.74%	3.54%	0.85%	4.66%	0.19%	-0.01%	1.65%	0.39%	0.27%	1.32%	3.45%	5.47%	1.95%	0.05%
9	0.06%	0.28%	0.60%	2.13%	0.70%	5.40%	2.09%	1.13%	2.98%	0.14%	-0.01%	0.61%	0.23%	0.06%	0.63%	2.88%	5.11%	2.19%	0.03%
10	0.05%	0.14%	0.24%	1.85%	0.47%	4.16%	1.69%	0.44%	2.67%	0.04%	-0.01%	0.61%	0.06%	0.11%	0.31%	2.52%	5.78%	1.55%	0.02%
11	0.03%	0.09%	0.16%	1.79%	0.49%	2.21%	0.76%	0.20%	1.83%	0.15%	-0.01%	1.42%	0.24%	0.31%	0.48%	1.72%	3.10%	0.79%	0.01%
12	0.03%	0.07%	0.13%	1.61%	0.39%	1.77%	0.61%	0.18%	1.46%	0.07%		0.71%	0.12%	0.28%	0.38%	1.55%	2.48%	0.39%	
13	0.02%	0.06%	0.10%	1.45%	0.31%	1.42%	0.49%	0.16%	1.17%	0.04%		0.35%	0.06%	0.25%	0.31%	1.39%	1.99%	0.20%	
14	0.02%	0.04%	0.08%	1.30%	0.25%	1.13%	0.39%	0.14%	0.94%	0.02%		0.18%	0.03%	0.23%	0.24%	1.26%	1.59%	0.10%	
15	0.01%	0.04%	0.06%	1.17%	0.20%	0.91%	0.31%	0.13%	0.75%	0.01%		0.09%	0.01%	0.20%	0.20%	1.13%	1.27%	0.05%	
16	0.01%	0.03%	0.05%	1.06%	0.16%	0.73%	0.25%	0.12%	0.60%			0.04%	0.01%	0.18%	0.16%	1.02%	1.02%	0.02%	
17	0.01%	0.02%	0.04%	0.95%	0.13%	0.58%	0.20%	0.11%	0.48%			0.02%		0.17%	0.12%	0.92%	0.81%	0.01%	
18	0.01%	0.02%	0.03%	0.86%	0.10%	0.46%	0.16%	0.09%	0.38%			0.01%		0.15%	0.10%	0.82%	0.65%	0.01%	
19	0.01%	0.01%	0.03%	0.77%	0.08%	0.37%	0.13%	0.09%	0.31%			0.01%		0.13%	0.08%	0.74%	0.52%		
20		0.01%	0.02%	0.69%	0.07%	0.30%	0.10%	0.08%	0.25%					0.12%	0.06%	0.67%	0.42%		
21		0.01%	0.02%	0.62%	0.05%	0.24%	0.08%	0.07%	0.20%					0.11%	0.05%	0.60%	0.33%		
22		0.01%	0.01%	0.56%	0.04%	0.19%	0.07%	0.06%	0.16%					0.10%	0.04%	0.54%	0.27%		
23		0.01%	0.01%	0.51%	0.03%	0.15%	0.05%	0.06%	0.13%					0.09%	0.03%	0.49%	0.21%		
24			0.01%	0.45%	0.03%	0.12%	0.04%	0.05%	0.10%					0.08%	0.03%	0.44%	0.17%		
25			0.01%	0.41%	0.02%	0.10%	0.03%	0.05%	0.08%					0.07%	0.02%	0.39%	0.14%		
26			0.01%	0.37%	0.02%	0.08%	0.03%	0.04%	0.06%					0.06%	0.02%	0.35%	0.11%		
27				0.33%	0.01%	0.06%	0.02%	0.04%	0.05%					0.06%	0.01%	0.32%	0.09%		
28				0.30%	0.01%	0.05%	0.02%	0.03%	0.04%					0.05%	0.01%	0.29%	0.07%		
29				0.27%	0.01%	0.04%	0.01%	0.03%	0.03%					0.05%	0.01%	0.26%	0.06%		
30				0.24%	0.01%	0.03%	0.01%	0.03%	0.03%					0.04%	0.01%	0.23%	0.04%		
31				0.22%	0.01%	0.03%	0.01%	0.02%	0.02%					0.04%	0.01%	0.21%	0.04%		
32				0.20%		0.02%	0.01%	0.02%	0.02%					0.03%		0.19%	0.03%		
33				0.18%		0.02%	0.01%	0.02%	0.01%					0.03%		0.17%	0.02%		
34				0.16%		0.01%		0.02%	0.01%					0.03%		0.15%	0.02%		
35				0.14%		0.01%		0.02%	0.01%					0.02%		0.14%	0.01%		
36				0.13%		0.01%		0.01%	0.01%					0.02%		0.12%	0.01%		
37				0.12%		0.01%		0.01%	0.01%					0.02%		0.11%	0.01%		
38				0.10%		0.01%		0.01%						0.02%		0.10%	0.01%		
39				0.09%				0.01%						0.02%		0.09%	0.01%		
40				0.08%				0.01%						0.01%		0.08%			
41																			
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Disc. at 3.0%	97.4%	95.2%	92.5%	86.8%	93.9%	84.0%	89.4%	94.2%	87.2%	96.7%	98.4%	94.0%	96.8%	94.2%	93.8%	85.0%	84.4%	92.4%	97.9%
Disc. at 4.0%	96.6%	93.7%	90.3%	83.3%	92.1%	79.5%	86.3%	92.4%	83.7%	95.7%	97.9%	92.2%	95.8%	92.5%	91.9%	81.1%	80.1%	90.2%	97.2%
Disc. at 5.0%	95.8%	92.2%	88.1%	80.3%	90.3%	75.4%	83.4%	90.8%	80.3%	94.7%	97.5%	90.5%	94.8%	90.8%	90.2%	77.5%	76.2%	88.0%	96.6%
Avg Time to Pmt (Years)	0.9	1.7	2.7	5.4	2.2	6.1	3.9	2.1	4.8	1.1	0.5	2.2	1.1	2.2	2.3	6.0	6.0	2.7	0.7

Exhibit A2-5B
Reserves: Payment Pattern by LOB—40-Year Runoff Method

Year	A-HO	B-PPA	C-CA	D-WC	E-CMP	F1-MPL-O	F2-MPL-C	G-SL	H-OL	I-SP	J-APD	K-Fid/Sur	L-Other	M-Intl	N-Re-Prop	O-Re-Liab	R-PL	S-FG/MG	T-Wrnty
1																			
2	66.70%	48.06%	36.69%	16.74%	33.61%	17.73%	28.36%	37.38%	21.12%	68.94%	104.41%	40.04%	56.71%	41.96%	44.31%	14.71%	18.28%	38.18%	73.07%
3	15.75%	23.52%	26.30%	12.01%	20.59%	17.15%	22.64%	18.20%	18.17%	14.96%	-8.54%	18.38%	16.04%	19.49%	20.42%	13.06%	15.63%	22.05%	13.40%
4	7.21%	12.80%	16.93%	9.22%	14.40%	15.27%	15.52%	11.29%	14.46%	5.92%	0.14%	10.51%	8.49%	11.03%	10.38%	10.54%	13.02%	12.17%	6.73%
5	3.74%	6.64%	9.28%	7.47%	8.87%	12.51%	10.28%	7.79%	10.87%	3.41%	2.00%	7.71%	5.47%	5.43%	6.27%	8.67%	10.53%	9.43%	3.40%
6	2.14%	3.35%	4.50%	6.28%	5.61%	9.60%	6.58%	4.89%	8.02%	2.49%	1.03%	5.82%	4.13%	3.31%	4.66%	7.19%	8.31%	5.65%	1.72%
7	1.31%	1.86%	2.27%	5.45%	3.78%	6.87%	4.42%	3.59%	5.93%	1.66%	0.37%	4.51%	2.78%	1.99%	3.15%	5.86%	6.85%	3.03%	0.87%
8	0.85%	1.12%	1.24%	4.80%	2.71%	4.84%	3.19%	2.72%	4.57%	0.81%	0.63%	3.69%	2.23%	1.81%	2.34%	4.93%	5.60%	3.34%	0.43%
9	0.58%	0.72%	0.75%	4.29%	2.07%	3.64%	2.16%	2.19%	3.48%	0.60%	0.40%	3.24%	1.60%	1.50%	1.58%	4.31%	4.58%	2.76%	0.22%
10	0.43%	0.48%	0.46%	3.86%	1.66%	2.68%	1.56%	1.50%	2.78%	0.39%	-0.18%	2.55%	1.08%	1.45%	1.24%	3.78%	3.69%	1.69%	0.11%
11	0.32%	0.36%	0.35%	3.48%	1.39%	1.94%	1.07%	1.23%	2.15%	0.43%	-0.26%	1.80%	0.79%	1.49%	1.16%	3.29%	2.77%	0.85%	0.05%
12	0.26%	0.28%	0.28%	3.12%	1.11%	1.56%	0.86%	1.10%	1.72%	0.21%		0.89%	0.38%	1.33%	0.93%	2.94%	2.21%	0.43%	
13	0.20%	0.21%	0.22%	2.79%	0.89%	1.25%	0.69%	0.98%	1.37%	0.11%		0.44%	0.18%	1.18%	0.74%	2.62%	1.77%	0.22%	
14	0.16%	0.15%	0.17%	2.49%	0.71%	1.00%	0.55%	0.88%	1.10%	0.05%		0.22%	0.08%	1.05%	0.59%	2.33%	1.41%	0.11%	
15	0.11%	0.12%	0.13%	2.22%	0.56%	0.80%	0.44%	0.79%	0.88%	0.02%		0.11%	0.03%	0.92%	0.47%	2.07%	1.13%	0.05%	
16	0.09%	0.09%	0.11%	1.98%	0.45%	0.64%	0.35%	0.70%	0.70%			0.05%	0.01%	0.82%	0.37%	1.84%	0.90%	0.02%	
17	0.07%	0.07%	0.08%	1.77%	0.35%	0.51%	0.28%	0.62%	0.56%			0.03%		0.74%	0.29%	1.63%	0.71%	0.01%	
18	0.05%	0.05%	0.06%	1.57%	0.28%	0.41%	0.22%	0.55%	0.45%			0.01%		0.64%	0.24%	1.44%	0.57%	0.01%	
19	0.03%	0.04%	0.05%	1.40%	0.22%	0.33%	0.18%	0.49%	0.36%					0.57%	0.19%	1.27%	0.45%		
20		0.03%	0.04%	1.24%	0.18%	0.26%	0.14%	0.44%	0.29%					0.50%	0.15%	1.12%	0.36%		
21		0.02%	0.03%	1.10%	0.13%	0.21%	0.11%	0.39%	0.23%					0.44%	0.12%	0.98%	0.28%		
22		0.02%	0.02%	0.97%	0.10%	0.17%	0.09%	0.34%	0.18%					0.38%	0.09%	0.86%	0.22%		
23		0.01%	0.02%	0.86%	0.08%	0.13%	0.07%	0.30%	0.14%					0.33%	0.07%	0.75%	0.17%		
24			0.01%	0.75%	0.07%	0.11%	0.06%	0.26%	0.11%					0.28%	0.06%	0.65%	0.14%		
25			0.01%	0.66%	0.05%	0.09%	0.04%	0.23%	0.09%					0.24%	0.05%	0.56%	0.11%		
26				0.58%	0.04%	0.07%	0.04%	0.20%	0.07%					0.20%	0.04%	0.48%	0.08%		
27				0.50%	0.03%	0.05%	0.03%	0.17%	0.05%					0.18%	0.03%	0.41%	0.07%		
28				0.43%	0.02%	0.04%	0.02%	0.14%	0.04%					0.14%	0.02%	0.34%	0.05%		
29				0.37%	0.02%	0.03%	0.02%	0.13%	0.03%					0.12%	0.02%	0.28%	0.03%		
30				0.32%	0.01%	0.03%	0.01%	0.11%	0.02%					0.09%	0.01%	0.23%	0.02%		
31				0.27%	0.01%	0.02%	0.01%	0.09%	0.02%					0.07%	0.01%	0.18%	0.02%		
32				0.23%		0.02%	0.01%	0.07%	0.01%					0.06%		0.16%	0.01%		
33				0.19%		0.01%		0.06%	0.01%					0.05%		0.13%	0.01%		
34				0.16%		0.01%		0.05%	0.01%					0.05%		0.11%	0.01%		
35				0.13%		0.01%		0.04%	0.01%					0.04%		0.09%	0.01%		
36				0.10%		0.01%		0.03%						0.03%		0.07%			
37				0.08%				0.02%						0.03%		0.05%			
38				0.06%				0.02%						0.03%		0.04%			
39				0.04%				0.01%						0.02%		0.02%			
40				0.02%				0.01%						0.01%		0.01%			
41																			
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Disc. at 3.0%	96.3%	95.1%	94.3%	82.7%	92.1%	89.2%	92.0%	90.9%	89.4%	96.5%	98.4%	92.9%	95.1%	91.2%	93.3%	83.5%	88.0%	93.6%	97.0%
Disc. at 4.0%	95.1%	93.7%	92.6%	78.3%	89.8%	86.1%	89.6%	88.4%	86.4%	95.4%	97.8%	90.8%	93.6%	88.9%	91.3%	79.3%	84.7%	91.6%	96.1%
Disc. at 5.0%	94.0%	92.2%	91.0%	74.4%	87.7%	83.2%	87.5%	86.1%	83.7%	94.3%	97.3%	88.8%	92.2%	86.7%	89.5%	75.5%	81.6%	89.8%	95.2%
Avg Time to Pmt (Years)	2.3	2.7	3.0	8.1	4.0	5.1	4.0	4.6	5.0	2.3	1.6	3.6	2.8	4.5	3.5	7.7	5.6	3.3	2.0

14. APPENDIX 3—RDHA and 40-Year Truncated Payment Pattern

Risk Development with Age

Many lines of business have AY payments extending beyond 10 years. For example, Exhibit A2-3 shows that unpaid losses from AYs of ages 10 and over at December 31, 2017, are 1.7% for A-HO, 31% for D-WC, and 42.9% for O-Re-Liab.

Exhibit A3-1 below shows how RRRs develop as the length of the risk development horizon increases from the end of year one to the end of year 10 for three LOBs.[82] The reserve risk ratio at each age is the 87.5th percentile of RRRs at that age. The numerator of the RRR at age "N" is the change in the reported ultimate net incurred losses from year 1 to year N. The ratio's denominator is the unpaid losses at the end of year 1.

Looking at the ratios, we see that the ratio increases with increasing age. For example, looking at O-Re-Liab, scanning across the columns, the one-year 87.5th percentile adverse development begins at 25.3% of initial reserves, shown in the '2 yrs' column, and increases to 187.3% at year ten. Moreover, even for the most mature data, e.g., years 8-10, the ratio increases from 152.6% to 187.3%.

Exhibit A3-1
Development of 87.5th Percentile Reserve Risk Ratio as Risk Development Horizon Expands from Year 1 to Year 10

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	87.5 percentile incurred loss change as a percentage of reserves at year 1								
LOB	2 yrs	3 yrs	4 yrs	5 yrs	6 yrs	7 yrs	8 yrs	9 yrs	10 yrs
A-HO	18.8%	22.2%	23.7%	23.6%	25.2%	25.8%	25.8%	26.1%	26.6%
change		3.5%	1.5%	-0.1%	1.7%	0.6%	0.0%	0.3%	0.5%
WC	15.6%	22.5%	30.4%	34.5%	37.9%	38.2%	45.0%	46.0%	49.1%
D-Change		6.9%	7.9%	4.1%	3.3%	0.4%	6.8%	0.9%	3.1%
O-Re-Liab	25.3%	43.8%	65.4%	96.5%	110.8%	126.2%	152.6%	171.3%	187.3%
Change		18.5%	21.7%	31.0%	14.4%	15.4%	26.4%	18.7%	16.1%

The most mature data point in our analysis is at age 10. It is reasonable to expect additional adverse development in years 10 and over.

Developing the tools to quantify premium and reserve risk beyond year ten is outside the scope of this analysis. Instead, we limit the investment income credit in the IIA by using the 40-year truncated payment pattern.

[82] The data used for this chart is at the company-level for statement years 1997, 2007, and 2017 only. Data is not consolidated into pools and no filters have been applied (e.g., for company size). We believe the findings from this simpler dataset also apply to the filtered data set we use to calculate risk factors for this analysis.

40-Year Truncated Payment Patterns

Exhibits A3-2A and 2B below show the 40-year truncated payment patterns. For payment periods 1-9, these equal the 40-year runoff payment patterns we show in Exhibit A2-5A and A2-5B for premium and reserve risk, respectively. Payment period 10+ is the sum of all payments in year 10 and beyond.

Exhibit A3-2A
Premium: 40-Year Truncated Payment Pattern by LOB

Year	A-HO	B-PPA	C-CA	D-WC	E-CMP	F1-MPL-O	F2-MPL-C	G-SL	H-OL	I-SP	J-APD	K-Fid/Sur	L-Other	M-Intl	N-Re-Prop	O-Re-Liab	R-PL	S-FG/MG	T-Wrnty
1	73.14%	41.13%	18.94%	18.87%	41.63%	0.65%	4.66%	37.04%	6.81%	57.92%	96.50%	28.36%	61.07%	33.51%	27.10%	11.21%	4.77%	18.13%	84.13%
2	20.31%	30.07%	23.63%	22.86%	22.37%	3.74%	18.74%	32.60%	13.85%	31.94%	3.84%	39.86%	29.46%	35.05%	37.83%	11.63%	10.47%	32.22%	12.91%
3	3.53%	13.30%	20.88%	13.42%	11.09%	10.46%	23.82%	11.74%	16.69%	5.79%	-0.29%	15.94%	4.87%	14.91%	16.16%	16.50%	12.22%	19.97%	1.46%
4	1.44%	7.55%	16.64%	8.42%	9.61%	15.08%	17.71%	5.96%	15.89%	1.87%	-0.01%	3.63%	1.81%	8.19%	6.85%	12.11%	13.41%	8.03%	0.73%
5	0.67%	3.97%	10.27%	5.73%	5.62%	16.13%	12.53%	4.75%	12.43%	0.67%	0.02%	2.73%	0.74%	3.17%	3.25%	9.69%	12.70%	7.57%	0.37%
6	0.35%	1.79%	4.76%	4.00%	3.16%	15.23%	7.29%	2.15%	9.06%	0.61%	0.00%	2.28%	0.72%	1.50%	2.65%	8.20%	7.69%	5.73%	0.19%
7	0.19%	0.88%	2.22%	3.14%	1.85%	11.35%	4.14%	1.43%	5.82%	0.54%	-0.02%	1.50%	0.18%	0.26%	1.53%	5.32%	6.88%	1.09%	0.10%
8	0.11%	0.47%	1.05%	2.45%	1.08%	6.74%	3.54%	0.85%	4.66%	0.19%	-0.01%	1.65%	0.39%	0.27%	1.32%	3.45%	5.47%	1.95%	0.05%
9	0.06%	0.28%	0.60%	2.13%	0.70%	5.40%	2.09%	1.13%	2.98%	0.14%	-0.01%	0.61%	0.23%	0.06%	0.63%	2.88%	5.11%	2.19%	0.03%
10+	0.20%	0.56%	1.01%	18.98%	2.89%	15.22%	5.48%	2.35%	11.81%	0.33%	-0.02%	3.44%	0.53%	3.08%	2.68%	19.01%	21.28%	3.12%	0.03%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Disc. at 3.0%	97.4%	95.2%	92.6%	89.5%	94.1%	85.1%	89.8%	94.5%	88.1%	96.7%	98.4%	94.1%	96.8%	94.6%	94.0%	87.6%	85.9%	92.5%	97.9%
Disc. at 4.0%	96.6%	93.7%	90.4%	86.5%	92.3%	80.8%	86.8%	92.8%	84.7%	95.7%	97.9%	92.3%	95.8%	93.0%	92.2%	84.1%	81.9%	90.2%	97.2%
Disc. at 5.0%	95.8%	92.3%	88.2%	83.6%	90.6%	76.8%	83.9%	91.2%	81.5%	94.7%	97.5%	90.6%	94.8%	91.4%	90.5%	80.7%	78.2%	88.1%	96.6%

Exhibit A3-2B
Reserves: 40-Year Truncated Payment Pattern by LOB

Year	A	B	C	D	E	F1	F2	G	H	I	J	K	L	M	N+P	O	R	S	T
0	A-HO	B-PPA	C-CA	D-WC	E-CMP	F1-MPL-O	F2-MPL-C	G-SL	H-OL	I-SP	J-APD	K-Fid/Sur	L-Other	M-Intl	N-Re-Prop	O-Re-Liab	R-PL	S-FG/MG	T-Wrnty
1																			
2	66.70%	48.06%	36.69%	16.74%	33.61%	17.73%	28.36%	37.38%	21.12%	68.94%	104.41%	40.04%	56.71%	41.96%	44.31%	14.71%	18.28%	38.18%	73.07%
3	15.75%	23.52%	26.30%	12.01%	20.59%	17.15%	22.64%	18.20%	18.17%	14.96%	-8.54%	18.38%	16.04%	19.49%	20.42%	13.06%	15.63%	22.05%	13.40%
4	7.21%	12.80%	16.93%	9.22%	14.40%	15.27%	15.52%	11.29%	14.46%	5.92%	0.14%	10.51%	8.49%	11.03%	10.38%	10.54%	13.02%	12.17%	6.73%
5	3.74%	6.64%	9.28%	7.47%	8.87%	12.51%	10.28%	7.79%	10.87%	3.41%	2.00%	7.71%	5.47%	5.43%	6.27%	8.67%	10.53%	9.43%	3.40%
6	2.14%	3.35%	4.50%	6.28%	5.61%	9.60%	6.58%	4.89%	8.02%	2.49%	1.03%	5.82%	4.13%	3.31%	4.66%	7.19%	8.31%	5.65%	1.72%
7	1.31%	1.86%	2.27%	5.45%	3.78%	6.87%	4.42%	3.59%	5.93%	1.66%	0.37%	4.51%	2.78%	1.99%	3.15%	5.86%	6.85%	3.03%	0.87%
8	0.85%	1.12%	1.24%	4.80%	2.71%	4.84%	3.19%	2.72%	4.57%	0.81%	0.63%	3.69%	2.23%	1.81%	2.34%	4.93%	5.60%	3.34%	0.43%
9	0.58%	0.72%	0.75%	4.29%	2.07%	3.64%	2.16%	2.19%	3.48%	0.60%	0.40%	3.24%	1.60%	1.50%	1.58%	4.31%	4.58%	2.76%	0.22%
10+	1.72%	1.93%	2.04%	33.74%	8.36%	12.39%	6.85%	11.95%	13.38%	1.21%	-0.44%	6.10%	2.55%	13.48%	6.89%	30.73%	17.20%	3.39%	0.16%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Disc. at 3.0%	96.3%	95.2%	94.5%	87.1%	92.7%	90.1%	92.5%	92.4%	90.5%	96.5%	98.4%	93.1%	95.1%	92.9%	93.8%	87.3%	89.3%	93.6%	97.0%
Disc. at 4.0%	95.2%	93.8%	92.8%	83.4%	90.5%	87.2%	90.3%	90.1%	87.7%	95.4%	97.8%	91.0%	93.6%	90.8%	92.0%	83.7%	86.2%	91.7%	96.1%
Disc. at 5.0%	94.1%	92.4%	91.2%	79.9%	88.5%	84.5%	88.1%	88.0%	85.0%	94.4%	97.3%	89.0%	92.2%	88.8%	90.2%	80.3%	83.3%	89.9%	95.2%

15.APPENDIX 4—Impact of Changes in Payment Pattern Methods

This Appendix shows the indicated IIAs and the risk charges for each of the four payment pattern/interest rate combinations in Table 4.1 by LOB. It also shows the percentage change in risk charges from the current risk charges to the risk charges using the 40-year truncated payment pattern with a 4% interest rate.

Exhibit A4-1A
Premium: Current and Indicated IIAs and Risk Charges
Various Payment Pattern Methods/ 5% and 4%Interest Rates
From Largest to Smallest Indicated Increase in Risk Charge (Column 12)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
LOB	IIAs					Risk Factor	Premium Risk Charges 2021 Formula Line 4 and IIA as shown:				4.0% 40 Yr Trunc vs 2022 Formula	
	2022 @5%	2017 Pay Data 5%	Trunc 5%	Trunc 4%	Dura-tion	2022 LIne 4	2022 Formula	2017 Pay Data 5%	Trunc 5%	Trunc 4%	% Risk (11)/(8)-100%	% Premium (11)-(8)
T-Wrnty	0.904	0.968	0.966	0.972	0.7	0.854	3.0%	8.5%	8.3%	8.9%	194.8%	5.8%
O-Re-Liab	0.777	0.796	0.807	0.841	4.8	1.322	29.5%	31.9%	33.5%	37.9%	28.5%	8.4%
F2-MPL-C	0.827	0.837	0.839	0.868	3.6	1.130	18.9%	20.0%	20.3%	23.5%	24.3%	4.6%
H-OL	0.816	0.825	0.815	0.847	4.3	1.013	13.0%	13.9%	12.9%	16.2%	24.0%	3.1%
D-WC	0.839	0.833	0.836	0.865	4.0	1.044	13.8%	13.1%	13.5%	16.4%	19.3%	2.7%
R-PL	0.774	0.780	0.782	0.819	5.3	1.263	30.7%	31.5%	31.7%	36.4%	18.5%	5.7%
G-SL	0.898	0.913	0.912	0.928	1.9	0.922	16.6%	18.0%	17.9%	19.4%	16.5%	2.7%
E-CMP	0.896	0.902	0.906	0.923	2.0	0.883	14.8%	15.3%	15.7%	17.2%	16.4%	2.4%
J-APD	0.971	0.971	0.975	0.979	0.5	0.836	4.4%	4.4%	4.7%	5.1%	16.1%	0.7%
F1-MPL-O	0.767	0.755	0.768	0.808	5.6	1.668	53.4%	51.5%	53.5%	60.2%	12.7%	6.8%
N-Re-Prop	0.893	0.887	0.905	0.922	2.0	1.170	31.2%	30.5%	32.6%	34.6%	10.8%	3.4%
B-PPA	0.925	0.924	0.923	0.937	1.6	0.969	12.5%	12.4%	12.3%	13.6%	9.4%	1.2%
C-CA	0.890	0.888	0.882	0.904	2.5	1.010	18.5%	18.2%	17.7%	19.8%	7.4%	1.4%
L-Other	0.947	0.945	0.948	0.958	1.1	0.935	14.2%	13.9%	14.3%	15.2%	7.4%	1.0%
K-Fid/Sur	0.904	0.919	0.906	0.923	2.0	0.854	27.2%	28.5%	27.4%	28.8%	6.1%	1.7%
A-HO	0.954	0.956	0.958	0.966	0.9	0.936	18.2%	18.4%	18.6%	19.3%	6.1%	1.1%
I-SP	0.949	0.946	0.947	0.957	1.1	0.863	12.0%	11.7%	11.9%	12.7%	6.0%	0.7%
M-Intl	0.905	0.907	0.914	0.930	1.9	1.234	55.6%	55.8%	56.7%	58.7%	5.5%	3.1%
S-FG/MG	0.884	0.909	0.881	0.902	2.5	1.598	75.4%	79.5%	74.9%	78.3%	3.9%	2.9%
Avg	0.915	0.916	0.917	0.932		0.950	13.5%	13.6%	13.7%	15.2%	12.1%	1.6%

This Exhibit provides LOB detail related to Table 4.1A.
Before WC tabular reserve adjustment.
Column 6 "Duration" using Macaulay duration using three-year Treasury yields at October 2022. See Appendix 5. Provided for background; not used in this calculation.

Exhibit A4-1B
Reserves: Current and Indicated IIAs and Risk Charges
Various Payment Pattern Methods/ 5% and 4%Interest Rates
From Largest to Smallest Indicated Increase in Risk Charge (Column 12)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
LOB	IIAs					Risk Factor	Reserve Risk Charges 2022 Formula Line 4 and IIA as shown:				4.0% 40 Yr Trunc vs 2022 Formula	
	2022 @5%	2017 Pay Data 5%	Trunc 5%	Trunc 4%	Dura-tion	2022 LIne 4	2022 Formula	2017 Pay Data 5%	Trunc 5%	Trunc 4%	% Risk (11)/(8)-100%	% Reserve (11)-(8)
M-Intl	0.874	0.932	0.888	0.908	2.6	0.359	18.8%	26.7%	20.7%	23.4%	24.7%	4.6%
F2-MPL-C	0.883	0.887	0.881	0.903	2.6	0.276	12.7%	13.2%	12.5%	15.2%	19.7%	2.5%
E-CMP	0.876	0.895	0.885	0.905	2.5	0.494	30.9%	33.7%	32.2%	35.3%	14.2%	4.4%
C-CA	0.911	0.914	0.912	0.928	1.9	0.276	16.2%	16.6%	16.3%	18.4%	13.3%	2.2%
A-HO	0.938	0.943	0.941	0.952	1.2	0.213	13.8%	14.4%	14.2%	15.5%	12.5%	1.7%
B-PPA	0.928	0.925	0.924	0.938	1.6	0.179	9.4%	9.1%	8.9%	10.6%	12.4%	1.2%
H-OL	0.852	0.860	0.850	0.877	3.5	0.531	30.4%	31.6%	30.2%	34.2%	12.3%	3.8%
T-Wrnty	0.940	0.976	0.952	0.961	1.0	0.371	28.9%	33.8%	30.5%	31.8%	10.0%	2.9%
N-Re-Prop	0.901	0.904	0.902	0.920	2.1	0.415	27.5%	27.9%	27.6%	30.1%	9.5%	2.6%
G-SL	0.890	0.904	0.880	0.901	2.8	0.304	16.1%	17.9%	14.8%	17.5%	9.2%	1.5%
R-PL	0.841	0.828	0.833	0.862	3.9	0.802	51.5%	49.2%	50.1%	55.3%	7.4%	3.8%
F1-MPL-O	0.865	0.850	0.845	0.872	3.6	0.383	19.6%	17.6%	16.9%	20.6%	5.1%	1.0%
D-WC	0.830	0.827	0.799	0.834	5.5	0.344	11.6%	11.2%	7.4%	12.0%	4.2%	0.5%
J-APD	0.976	0.974	0.973	0.978	0.5	0.155	12.7%	12.6%	12.4%	13.0%	2.1%	0.3%
O-Re-Liab	0.838	0.839	0.803	0.837	5.2	0.656	38.8%	38.9%	32.9%	38.5%	-0.6%	-0.2%
I-SP	0.966	0.966	0.944	0.954	1.2	0.246	20.4%	20.4%	17.6%	18.9%	-7.3%	-1.5%
S-FG/MG	0.926	0.957	0.899	0.917	2.1	0.179	9.2%	12.9%	6.0%	8.2%	-11.1%	-1.0%
K-Fid/Sur	0.940	0.956	0.890	0.910	2.3	0.371	28.9%	31.0%	22.1%	24.8%	-14.2%	-4.1%
L-Other	0.967	0.963	0.922	0.936	1.6	0.220	18.0%	17.5%	12.5%	14.3%	-20.7%	-3.7%
Avg	0.879	0.881	0.867	0.890		0.365	19.5%	19.8%	17.9%	21.2%	8.5%	1.7%

This Exhibit provides LOB detail related to Table 4.1B.
Before WC tabular reserve adjustment.
Column 6 "Duration" using Macaulay duration using three-year Treasury yields at October 2022. See Appendix 5. Provided for background; not used in this calculation.

16. APPENDIX 5—PV Method

This Appendix provides supporting material related to the following:

1. Implementing RDHA with PV indicated risk charges
2. Additional PV and Undiscounted Regression Statistics
3. Sample duration calculation
4. Selection of interest rate lag and average period

Implementing RDHA with PV Indicated Risk Charges

In the PV Method, we initially calculate risk charges using the 40-year runoff payment pattern, i.e., before RDHA. Our initial PV indicated risk charges are also before catastrophe adjustments.

Exhibits A5-1A and 1B show the calculation of PV indicated risk charges after RDHA and after catastrophe adjustments as follows:

Column 2 shows the PV indicated risk charges by LOB based on the analysis we describe in Section 5. These use 1988-2017 experience, the 40-year runoff payment pattern, and the interest rates varying yearly. These are before any catastrophe adjustment. [83]

Column 3 shows the IIA based on the 40-year runoff payment pattern and the 4% interest rate from Appendix 2, Exhibit A2-5.

Column 4 shows the undiscounted risk charge based on columns 2 and 3 as follows:

- Premium Risk: (4) = {(2) +1.0 - (12)}/ (3) + (12) -100%.
- Reserve Risk: (4) = [1.0+(2)]/ (3) – 100%

These formulas are the reverse of the risk charge formulas shown in Notes to Table 1.1.

Column 5 shows the indicated Line 4 risk factor based on the undiscounted risk charge in column 4 using the following formulas:

- Premium Risk factor: (5) = (4) + 1.0 – (12)
- Reserve risk factor: (5) = (4)

Column 6 shows the IIA based on the 40-year truncated payment patterns and a 4% interest rate, Appendix 3, Exhibits A3-2A and 2B for premium and reserve risk, respectively.

Column 7 is the indicated risk charge, including the RDHA, before catastrophe adjustment:

[83] We apply the RDHA to the indicated risk charges before the catastrophe adjustments, as the underlying data is before catastrophe adjustments. That produces slightly higher RDHAs than if we applied the catastrophe adjustments to indicated risk charges net of the catastrophe adjustments.

- Premium risk charge: (7) = (5) * (6) +(12) -100%
- Reserve risk charge: (7) = {1.0 + (5)} * (6) -100%

Column 8: Current catastrophe adjustment from Table 7.1

Column 9: Risk charge with RDHA net of current catastrophe risk charge

- Premium or Reserve Risk: (9) = (8) – (7)

Column 10 shows the RDHA as a percentage of the risk charge

- Premium or Reserve Risk: (10) = {(9) – (2)}/ Absolute value (2)

Column 11 shows the RDHA as a percentage of premium or reserves.

- Premium or Reserve Risk: (10) = (9) – (2)

Two observations from column 10 are the following:

- The risk development horizon risk adjustment is more significant for reserve risk than for premium risk. The all-lines combined RDHA % risk is 14.9% of reserve risk versus 3.2% of premium risk. A larger RDHA for reserve risk is expected because the payment pattern is generally longer for reserve risk than for premium risk.
- The RDHA is largest for the longest tail LOBs, D-WC and O-Re-Liab.

Exhibit A5-1A
Premium: Risk Development Horizon Adjustment (RDHA)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
LOB	PV Indicated Risk Charge gross of cat adj	Indicated IIA/ 4% runoff	Undiscounted Indicated risk charge before RDHA	Indicated Risk Factor (Line 4)	Indicated IIA/ 4% trunc	PV Indicated Risk Charge/ with RDHA/ gross of cat adj	Current Cat Adjustment	Indicated Risk Charge/ with RDHA/ net of current cat adj	RDHA % Risk	RDHA % Premium	Expense Ratio (Table 1.1)
A-HO	21.3%	96.6%	24.6%	95.7%	96.6%	21.3%	2.8%	18.6%	0.1%	0.0%	28.9%
B-PPA	13.7%	93.7%	19.8%	97.0%	93.7%	13.7%		13.7%	0.3%	0.0%	22.8%
C-CA	20.1%	90.3%	29.9%	101.3%	90.4%	20.1%		20.1%	0.4%	0.1%	28.6%
D-WC	8.9%	83.3%	25.5%	99.3%	86.5%	12.0%		12.0%	34.6%	3.1%	26.2%
E-CMP	17.3%	92.1%	24.4%	88.7%	92.3%	17.6%	1.8%	15.9%	1.4%	0.2%	35.6%
F1-MPL-O	34.5%	79.5%	62.7%	137.2%	80.8%	36.3%		36.3%	5.0%	1.7%	25.5%
F2-MPL-C	23.9%	86.3%	39.5%	114.0%	86.8%	24.4%		24.4%	2.0%	0.5%	25.5%
G-SL	20.0%	92.4%	27.1%	93.3%	92.8%	20.4%	1.6%	18.9%	1.6%	0.3%	33.8%
H-OL	12.5%	83.7%	28.6%	98.2%	84.7%	13.5%		13.5%	8.2%	1.0%	30.4%
I-SP	9.4%	95.7%	13.0%	82.9%	95.7%	9.5%	1.6%	7.9%	0.1%	0.0%	30.1%
J-APD	5.4%	97.9%	7.2%	83.9%	97.9%	5.4%		5.4%	0.0%	0.0%	23.2%
K-Fid/Sur	10.5%	92.2%	15.6%	65.7%	92.3%	10.6%		10.6%	0.9%	0.1%	50.0%
L-Other	14.3%	95.8%	18.2%	92.6%	95.8%	14.3%		14.3%	0.1%	0.0%	25.6%
M-Intl	93.4%	92.5%	105.6%	161.7%	93.0%	94.3%		94.3%	0.9%	0.9%	43.9%
N-Re-Prop	39.6%	91.9%	49.5%	122.8%	92.2%	39.9%	6.9%	33.5%	0.8%	0.3%	26.7%
O-RE-Liab	19.6%	81.1%	41.3%	114.6%	84.1%	23.0%		23.0%	17.5%	3.4%	26.7%
R-PL	26.6%	80.1%	49.8%	116.8%	81.9%	28.6%		28.6%	7.8%	2.1%	33.0%
S-FG/MG	153.2%	90.2%	177.2%	243.0%	90.2%	153.4%		153.4%	0.1%	0.2%	34.1%
T-Wrnty	21.6%	97.2%	24.3%	98.5%	97.2%	21.6%		21.6%	0.0%	0.0%	25.8%
Avg	14.0%	92.7%	21.1%	94.1%	93.2%	14.4%	0.8%	13.7%	3.2%	0.4%	27.0%

Before WC tabular adjustment.

Exhibit A5-1B
Reserve: Risk Development Horizon Adjustment (RDHA)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
LOB	PV Indicated Risk Charge	Indicated IIA/ 4% runoff	Undiscounted Indicated risk charge before RDHA	Indicated Risk Factor (Line 4)	Indicated IIA/ 4% trunc	PV Indicated Risk Charge/ with RDHA/ gross of cat adj	Current Cat Adjustment	Indicated Risk Charge/ with RDHA/ net of current cat adj	RDHA % Risk	RDHA % Reserve
A-HO	16.4%	95.1%	22.4%	22.4%	95.2%	16.6%	0.0%	16.6%	0.8%	0.1%
B-PPA	12.8%	93.7%	20.4%	20.4%	93.8%	12.9%	0.0%	12.9%	1.3%	0.2%
C-CA	25.7%	92.6%	35.7%	35.7%	92.8%	25.9%	0.0%	25.9%	0.9%	0.2%
D-WC	-1.8%	78.3%	25.5%	25.5%	83.4%	4.6%	0.0%	4.6%	362.5%	6.4%
E-CMP	31.4%	89.8%	46.3%	46.3%	90.5%	32.5%	0.0%	32.5%	3.5%	1.1%
F1-MPL-O	8.0%	86.1%	25.4%	25.4%	87.2%	9.4%	0.0%	9.4%	18.1%	1.4%
F2-MPL-C	-1.5%	89.6%	9.8%	9.8%	90.3%	-0.9%	0.0%	-0.9%	43.4%	0.7%
G-SL	21.5%	88.4%	37.4%	37.4%	90.1%	23.9%	0.0%	23.9%	11.2%	2.4%
H-OL	27.4%	86.4%	47.4%	47.4%	87.7%	29.2%	0.0%	29.2%	6.6%	1.8%
I-SP	21.3%	95.4%	27.1%	27.1%	95.4%	21.3%	0.0%	21.3%	0.2%	0.1%
J-APD	11.2%	97.8%	13.6%	13.6%	97.8%	11.2%	0.0%	11.2%	-0.1%	0.0%
K-Fid/Sur	43.7%	90.8%	58.3%	58.3%	91.0%	44.0%	0.0%	44.0%	0.7%	0.3%
L-Other	14.6%	93.6%	22.4%	22.4%	93.6%	14.7%	0.0%	14.7%	0.6%	0.1%
M-Intl	81.2%	88.9%	103.9%	103.9%	90.8%	85.1%	0.0%	85.1%	4.9%	4.0%
N-Re-Prop	19.6%	91.3%	31.0%	31.0%	92.0%	20.4%	0.0%	20.4%	4.3%	0.8%
O-RE-Liab	19.9%	79.3%	51.3%	51.3%	83.7%	26.5%	0.0%	26.5%	33.4%	6.6%
R-PL	97.7%	84.7%	133.6%	133.6%	86.2%	101.3%	0.0%	101.3%	3.7%	3.6%
S-FG/MG	-5.1%	91.6%	3.5%	3.5%	91.7%	-5.0%	0.0%	-5.0%	1.8%	0.1%
T-Wrnty	30.2%	96.1%	35.5%	35.5%	96.1%	30.2%	0.0%	30.2%	0.0%	0.0%
Avg	16.7%	87.2%	34.1%	34.1%	89.0%	19.2%	0.0%	19.2%	14.9%	2.5%

Before WC tabular adjustment.

RDHA Sensitivity to Selected Interest Rate

The RDHA uses a 4% interest rate. Exhibit A5-2, below, shows the indicated risk charges with RDHAs using interest rates of 3% and 5%. The effect on risk charges of the different interest rates is small.

Exhibit A5-2
All-Line Average Indicated Risk Charge
Sensitivity of RDHA to Alternative Interest Rate Assumptions

(1)	(2)	(3)	(4)	(5)
Interest Rate	Indicated Risk Charge		Change in Indicated Risk Charge vs 4%	
	Premium	Reserves	Premium	Reserves
5%	13.76%	19.55%	0.5%	1.9%
4%	13.70%	19.18%	0.0%	0.0%
3%	13.62%	18.73%	-0.6%	-2.4%

Additional PV and Undiscounted Regression Statistics

The Tables in Section 5 show the relationships between undiscounted risk charges, PV risk charges, interest rates, and time, for 1980-2017 (2013 for reserves). Exhibits A5-3 and A5-4, below, provide some supplemental information.

The analysis in Section 5 used data from 1980-2017. Our calibration of risk charges uses experience for 1988 and subsequent years. Therefore, Exhibit A5-3 summarizes some of the regression statistics for the 1988 and subsequent years.

Exhibit A5-3
Additional Regression Statistics

Row	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	X and Y Regression Variables	Premium				Reserve			
		R-Squared		Slope-% Prem		R-Squared		Slope-% Reserve	
		All Yrs	≥88	All Yrs	≥88	All Yrs	≥88	All Yrs	≥88
(1)	Interest vs Time	84%	81%	-0.3%	-0.3%	81%	79%	-0.3%	-0.2%
(2)	Undisc vs Interest	54%	31%	271%	175%	75%	35%	729%	333%
(3)	Undisc vs. Time	34%	23%	-0.7%	-0.4%	57%	28%	-2.1%	-0.8%
(4)	Undisc vs. Time Scaled to PV Avg	NA	NA	-0.39%	-0.27%			-0.84%	-0.32%
(5)	PV vs Time	0.5%	1.0%	-0.05%	0.07%	26%	1.2%	-0.69%	0.11%

The columns labeled "All Yrs," show the information we discuss in Section 5. The columns labeled "≥88" show the corresponding values calculated for the years 1988 and subsequent. In any row, comparing any pair of columns, e.g., 2 and 3, 4 and 5, etc., the relationships between undiscounted

risk charges, PV risk charges, interest rates, and time are qualitatively similar for years beginning 1980 or years beginning 1988. While the relationships are somewhat less strong for the years beginning in 1988, these "≥88" statistics show that our interpretation remains reasonable for the period beginning in 1988.

Also, in Section 5, we compare the slopes of undiscounted risk charges to those of PV risk charges. The PV risk charges, being discounted, have lower values than the undiscounted risk charges. Therefore, all else equal, the slope of the PV risk charges as a percentage of premium or reserves will tend to be lower than that of the undiscounted risk charges as a percentage of premium/reserves. This can distort our comparison of the two slopes.

Table A5-4, below, rows 1 and 2 show the undiscounted and PV average premium and reserve risk charge for each set of years. Row 3 is the ratio of those values.

Exhibit A5-4
Additional Regression Information
Multi-Line Average Undiscounted and PV Risk Charges

Row	(1)	(2)	(3)	(4)	(5)
	Average Risk Charge	Premium Risk		Reserve Risk	
		All Yrs	≥88	All Yrs	≥88
(1)	Undiscounted	27.1%	23.0%	47.7%	34.9%
(2)	PV	14.8%	14.2%	18.7%	13.4%
(3)	Scaling Factor (3) = (2)/(1)	54.7%	61.5%	39.3%	38.3%

Exhibit A5-3, row 4, shows the undiscounted risk charge slope after the scaling factor from Exhibit A5-4, row 3. Comparing Exhibit A5-3, rows 4 and 5, we see that after adjustment, the slope of the undiscounted risk charges in Exhibit A5-3, row 4 remains further from zero than the slope of the PV risk charges Exhibit A5-3, row 4. This finding is consistent with our conclusion that PV indicated risk charges are more stable over time than the undiscounted indicated risk charges, during either period.

Duration Matching of U.S. Treasury Rates

Our PV indicated present value calculations use the average U.S. Treasury rates over the year two years before the AY (for premium risk) and two years before the initial reserve year (for reserve risk). In these U.S. Treasury rates, we match the U.S. Treasury security time to maturity to the duration of the payment patterns. We calculate duration-matched interest rates as follows:

- For each line of business, for each AY/initial reserve year, we first calculate the (Macaulay) duration of the payment pattern (either premium or reserve) using the average three-year maturity Treasury rate for the year, two years prior to the AY/initial reserve year.

- Using this duration, we interpolate between the two closest spot rates (above and below) to calculate the spot rate for discounting.

For example, in 2006, the R-PL duration using the three-year Treasury rate is 5.5 years. The two closest average spot rates from 2004 are the five-year average of 3.43% and the seven-year average of 3.87%. We interpolate between these rates as follows to obtain the duration-matched rate of 3.54% for premium risk as follows:

- 3.54% = 3.43% x (7-5.5) / (7-5) + 3.87% x (5.5-5) / (7-5)

We use this 3.54% interest rate and the 40-year runoff AY payment pattern for R-PL to discount 2006 company losses under the PV Method.

Interest Rate Sensitivity: Lags and Averaging Period

Our PV Method uses U.S. Treasury interest rates, with durations matched to the payment pattern by LOB, for average interest rates during the year, two years before the AY and two years before the initial reserve year. We refer to that as being "lagged by two years."

The rows in Exhibit A5-5 show the results of various methods of selecting U.S. Treasury interest rates, as follows:

- For premium risk, columns 3-5, the first four rows are based on the average U.S. Treasury interest rates during the AY and during years lagged by one, two, and three years from the AY, respectively.

  The final four rows use the two-year average of interest rates during the two years ending with the AY and during the two years lagged one, two, and three before the AY, respectively.

- For reserve risk, columns 6-8, the first four rows are the average U.S. Treasury interest rates during the initial reserve year and during years lagged one, two, and three years before the initial reserve year, respectively.

  For example, for AY 1988 and initial reserve year 1998, i.e., reserves at December 31, 1988, we use the 1986 U.S. Treasury interest rate for the row "One Yr Avg/Two Yrs Prior To AY."

  The final four rows consider the two-year average of interest rates during the two years ending with the initial reserve year and during the two years lagged one, two, and three years before the initial reserve year, respectively.

We select the average risk charge two years before for the AY and the initial reserve year considering the following:

- R-squared values for all years (columns 3 and 6),
- R-squared values for 1988 and subsequent (columns 4 and 7), and

- Resulting PV indicated risk charges using the years 1988 and subsequent data[84] (columns 5 and 8).

The selected interest rate period has the second highest of the eight R-squared values for both premium risk and reserve risk years 1988 and subsequent. The indicated risk charge is in the middle of the values from the methods with the highest three R-squared values.

Exhibit A5-5
Sensitivity to Variations in Interest Rate—R-squared values and Indicated Risk Charges
Average of Eight LOBs (Premium)/Seven LOBs (Reserve) Used in Section 5 PV Method

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Average period	Lag	Premium Risk			Reserve Risk		
		R-squared		PV Indicated	R-squared		PV Indicated
		All Yrs	≥88	Risk Charge	All Yrs	≥88	Risk Charge
One Year Average	Current	33.9%	17.0%	15.6%	58.9%	27.0%	18.6%
One Year Average	One Year	45.2%	26.3%	15.8%	70.3%	33.7%	17.6%
One Year Average	**Two years**	**54.2%**	**30.6%**	**15.6%**	**75.3%**	**34.7%**	**16.9%**
One Year Average	Three Years	55.0%	28.6%	15.1%	66.8%	30.6%	15.8%
Two Year Average	Current	40.6%	22.4%	16.1%	66.8%	31.6%	18.1%
Two Year Average	One Year	51.2%	29.6%	15.6%	75.6%	35.8%	17.2%
Two Year Average	Two years	56.6%	30.9%	15.3%	74.3%	34.6%	16.2%
Two Year Average	Three Years	50.3%	29.1%	14.8%	60.3%	31.4%	15.2%

Risk charges gross of cat risk adjustment, net of RDHA, and before WC tabular reserve adjustment.

[84] The final year is 2017 for premium risk and 2013 for reserve risk, as shown in Section 5.

17. APPENDIX 6—LOB Experience Before 1988

As noted in Section 5, we base the indicated risk charges on data for AYs and initial reserve years 1988 and subsequent.

Data for 1980-1987 is available for some LOBs. Exhibit A6-1A below shows the differences between the indicated risk charges including 1980-1987 data and those excluding those years, by LOB, for LOBs with any 1980-1987 data.

Exhibit A6-1A
Premium: PV Indicated Risk Charge—1980-1987, 1988-2017, All Years
Listed in Order of Increasing Difference Between "PV All" and "PV≥1988" (Column 5)

LOB	Indicated Premium Risk Charge					Change in Risk Charge	
	(1)	(2)	(3)	(4)		(5)	(6)
	2021 Formula	PV≥88	PV <88	PV all		((4)-(2))/(2)	(4)-(2)
						% risk factor	% Premium
A-HO	18.2%	18.6%	10.6%	16.7%		-10.1%	-1.9%
D-WC	13.8%	8.9%	5.7%	8.2%		-8.2%	-0.7%
M-Intl	55.6%	93.4%	71.3%	88.0%		-5.9%	-5.5%
F1-MPL-O	53.4%	34.5%	31.2%	33.9%		-1.8%	-0.6%
F2-MPL-C	18.9%	23.9%	5.9%	23.5%		-1.7%	-0.4%
R-PL	30.7%	26.6%	25.7%	26.4%		-0.5%	-0.1%
B-PPA	12.5%	13.7%	13.7%	13.7%		0.1%	0.0%
C-CA	18.5%	20.1%	22.6%	20.7%		3.1%	0.6%
E-CMP	14.8%	15.7%	21.7%	16.7%		6.6%	1.0%
G-SL	16.6%	18.6%	27.4%	21.4%		15.1%	2.8%
H-OL	13.0%	12.5%	46.7%	17.0%		36.0%	4.5%
O-Re-Liab	29.5%	19.6%	41.7%	27.5%		40.6%	8.0%

Before RDHA. Gross of catastrophe adjustment.

Regarding premium risk, we note that:

- Only 12 (of 19) LOBs have data before 1988.[85]
- Of the 12, three, F1-MPL-O, F2-MPL-C, and R-PL, have data for only some of the years before 1988.
- For 7 of the 12 LOBs, the effect of including the 1980-1987 data is, ±1% of premium.

[85] The limits on the availability of data in the early 1980s relate to the structure of the Annual Statement. For example, certain LOBs were consolidated with other LOBs in the early years, e.g., F1-MPL-O, F2-MPL-C, and R-PL. Also, the Annual Statement had Schedule O for Two-Year LOBs and Schedule P for Ten-LOBs. Our data is from Schedule P only.

- However, including the 1980-1987 data would produce large increases for H-OL and O-Re-Liab, lines known to have been very unprofitable in those years.

Exhibit A6-1B shows the same information for reserve risk.

Exhibit A6-1B
Reserve: PV Indicated Risk Charge—1980-1987, 1988-2017, All Years
Listed in Order of Increasing Difference Between "PV All" and PV≥1988" (Column 5)

LOB	Indicated Reserve Risk Charge					Change in Risk Charge	
	(1)	(2)	(3)	(4)		(5)	(6)
	2021 Formula	PV≥88	PV <88	PV all		((4)-(2))/(2)	(4)-(2)
						% risk factor	% Reserves
D-WC	11.6%	-1.8%	-11.7%	-3.1%		-77.7%	-1.4%
G-SL	16.1%	21.5%	30.8%	22.9%		6.6%	1.4%
C-CA	16.2%	25.7%	35.9%	27.5%		6.9%	1.8%
R-PL	51.5%	97.7%	152.1%	106.3%		8.7%	8.5%
B-PPA	9.4%	12.8%	19.7%	13.9%		9.0%	1.2%
A-HO	13.8%	16.4%	27.3%	18.5%		12.5%	2.1%
E-CMP	30.9%	31.4%	62.0%	37.0%		17.8%	5.6%
M-Intl	18.8%	81.2%	169.6%	98.9%		21.9%	17.7%
F1-MPL-O	19.6%	8.0%	54.0%	11.4%		42.6%	3.4%
F2-MPL-C	12.7%	-1.5%	17.1%	-0.9%		43.0%	0.7%
H-OL	30.4%	27.4%	102.5%	42.2%		54.1%	14.8%

Before RDHA.

Regarding reserve risk, we note the following:

- Only 11 (of 19) LOBs have any data before 1988.
- Of the 11, three, F1-MPL-O, F2-MPL-C, and R-PL, have data for only some of the years before 1988.
- The effect of including the 1980-1987 data would be large for some LOBs, particularly those LOBs known to have had extreme adverse reserve development in the early 1980s, e.g., H-OL, F1-MPL-O, and R-PL. We believe the risk charges are outside the level expected in a 38-year experience period (1980-2017).
- O-Re-Liab would likely also show high indicated reserve risk charges for the 1980-1987 period, but there is no O-Re-Liab reserve development data for that period.[86]
- Including the 1980-1987 data would produce large increases for most of these LOBs.

On balance, regarding premium and reserve risk, we exclude the 1980-1987 experience in our indicated risk charges, considering the following:

[86] Due to changes in the structure of Schedule P.

- We do not have data for all LOBs,
- The likelihood that the adverse indicated risk charges might be outside the range expected in a 38-year experience period, and
- We consider business issues related to the early 1980s compared to subsequent years, as discussed in the April 2021 Report, which we repeat in Exhibit A6-2 below.

We conclude that, as we did for the April 2021 Report, the PV indicated risk charges in this Report [August 2023] would not use the experience before 1988. However, we note the exclusion of 1980-1987 when discussing safety levels in Section 9.

Exhibit A6-2
Extract from April 2021 Report (pages 17-18)

Exclude AYs and Initial Reserve Years Prior to 1988

For this Report [April 2021] we have experience for AYs/Reserve Years 1980 to 1987 that was not available for the 2016 Report. Looking at indicated Risk Factors by decade, we find that for nearly all the liability LOBs, this oldest block of years shows the highest indicated PRFs and RRFs.

This pattern may be due to factors that might not be applicable to current conditions. For example, the 1993 Report on Reserve and Underwriting Risk Factors by the American Academy of Actuaries Property/Casualty Risk-Based Capital Task Force (page 4)[87] identified four reasons why the experience of the 1980's might not be suitable for projection of the future. These are:

- *The tort liability explosion, particularly in respect to asbestos and environmental liabilities.*
- *A great deal of naïve capacity, focused especially on general liability and reinsurance lines.*
- *High interest rates, creating intense pressures to engage in cash flow underwriting.*
- *High inflation rates.*

Other considerations include:

- Company loss reserving practices may have improved because of required actuarial opinions and increased regulatory, rating agency and management attention to reserving.
- The adverse experience in these years triggered expansion in the use of claims-made policies, pollution exclusions, asbestos exclusions, and other policy changes.
- Company pricing discipline and pricing methodology may have improved since the 1980s.

Therefore, in this Report [April 2021], we do not use the experience before 1988 because these early years may not be sufficiently relevant to the present conditions.

[87] American Academy of Actuaries Property/Casualty Risk-Based Capital Task Force, "Report on Reserve and Underwriting Risk Factors," May 1993.

18. APPENDIX 7—Catastrophe Adjustment to Indicated Premium Risk Charges

Section 7 discusses the data we use to select the catastrophe adjustments. There are important limitations related to that data, and we discuss those limitations below.

In 2013, the RBC formula added an "information only" risk component, R_{CAT}, based on the company's modeled exposure to hurricane and earthquake losses. In 2017, the R_{CAT} element officially became a part of the RBC Formula.

We determine the indicated premium risk factors with data that includes earthquake and hurricane losses. Therefore, to avoid double-counting catastrophe risk, we remove the effect of actual hurricanes and earthquakes from the experience data set, thereby reducing the otherwise applicable premium risk factors for the catastrophe-affected LOBs. We refer to this reduction as the catastrophe adjustment.

Scale of Catastrophe Adjustment

The impact of the catastrophe adjustment will vary by company. Overall, though, the dollar impact on industry RBC of catastrophe adjustments is as follows:

- Applying the current (i.e., incumbent) catastrophe adjustments to 2017 net earned premium, implies a $4.2 billion reduction in premium risk RBC.
- Applying the selected catastrophe adjustments to 2017 net earned premium, implies a $6.9 billion reduction in premium risk RBC.
- This is a $2.6 billion further reduction in premium risk RBC compared to the current catastrophe adjustments.[88]

The impacts on CAL are lower due to reductions due to IIAs by LOB, diversification between LOBs, and diversification between risk charge elements.

The approximate dollar magnitude of the selected catastrophe adjustments ($6.9 billion) should be seen relative to the rest of the RBC Formula. For example, for the U.S. P&C industry overall 2017 net earned premium is $541 billion, the 2017 premium RBC premium risk (R5) is $69 billion, the 2017 R_{CAT} is $51 billion, and the 2017 RBC CAL is $300 billion.[89]

The fact that R_{CAT} ($51 billion) is much larger than the dollar amount of the catastrophe adjustment ($6.9 billion) is reasonable because R_{CAT} is the modeled 99th percentile for hurricanes and earthquakes and the premium risk charges are calibrated at the 87.5th percentile.

[88] Approximately half of this $2.6 billion reduction relates to N-Re-Prop.

[89] The dollar magnitude of the selected catastrophe adjustments shown here is a simplified calculation and is intended as an overview. For example, we do not consider the diversification across RBC risk elements, R0, R1, etc., the diversification across LOBs in premium risk, or the own-company adjustment for the cat LOBs. Also, we apply the catastrophe adjustment to net earned premium while the RBC Formula applies them to net written premium.

Data

As part of implementing R_{CAT}, companies[90] report their current modeled exposure to catastrophe losses for all LOBs combined. In addition, companies report their actual U.S. and non-US catastrophe losses.

Companies report this hurricane and earthquake loss experience data in their confidential RBC Filings that are not publicly available. In this analysis, we use the term "Cat Data" to refer to the confidential RBC data from RBC forms PR101, PR102, …, and PR122, one form for each LOB. Cat Data in those forms provides the following fields for each LOB, company, and AY in each RBC Filing year:

- US Catastrophe Incurred Losses
- Non-US Catastrophe Incurred Losses
- Non-Catastrophe Incurred Losses
- Net Earned Premium (NEP)

In each RBC Filing, Cat Data contains 10 years of loss experience for each LOB, for both Ten-Year and Two-Year LOBs. The first RBC information Filing with Cat Data was as of December 2013, which provides data for AYs 2004-2013. The Cat Data for this review includes AYs 2004-2017. Appendix 9 shows the Academy Committee's instructions to Regulators to collect blinded "Cat Data."

The NAIC RBC Instructions for R_{CAT} (PR027) state that "modeled losses are to be entered using the insurance company's own insured **property** exposure information as inputs to the model."[91] Therefore, we understand that the catastrophe loss columns reported in RBC forms PR101 through PR122 include only property experience. Consistent with that understanding, we see zero catastrophe losses in LOBs like B-PPA, D-WC, F1-MPL-O, F2-MPL-C, and H-OL. We do not have an explanation for the small but non-zero raw indicated catastrophe adjustment for R-PL.

We understand that non-proportional reinsurance contracts covering both property and liability exposures (multiline) should be coded as O-Re-Liab. Consistent with that understanding, we observe a small but non-zero, raw indicated catastrophe adjustment for O-Re-Liab.

It might be the case that some reinsurers code non-proportional multiline reinsurance business under N-Re-Prop. We have not investigated how much, if any, insurance industry business is coded as N-Re-Prop instead of O-Re-Liab. The selected catastrophe adjustment is based on the data as reported.[92]

[90] Subject to exemptions based on certain de minimis exposure rules.
[91] Refer to 2022 NAIC P&C RBC Instructions for forms PR027A and PR027B, see pages 99 and 100 of the pdf.
[92] Except for R-PL, where we expect zero catastrophe loss in RBC Cat Data.

Credibility

The number of data points is a measure of the statistical credibility of the data. Column 2 of Exhibit A7-1 shows the number of data points in Cat Data, where each data point represents an LR for a Company or Pool for a particular line of business and AY. Column 3 equals 12.5% of column 2, which is the number of data points in excess of the 87.5th percentile.

For some LOBs, most notably M-Intl, the indicated catastrophe adjustment is based on relatively few data points. The total number of data points for M-Intl is only 109; hence, only the14 highest of those data points exceed the raw indicated catastrophe adjustment. We consider this relative credibility in our catastrophe adjustment selections.

Exhibit A7-1
Number of Data Points

(1)	(2)	(3)
LOB	2004-17 # data points	
	Total	12.5% of (2)
A-HO	4,924	616
E-CMP	3,441	430
G-SL	708	89
I-SP	4,735	592
J-APD	4,689	586
M-Intl	109	14
N-Re-Prop	427	53
O-Re-Liab	357	45
R-PL	1,119	140

Data Quality: General

The catastrophe loss experience in RBC Filings is not subject to the same level of audit and transparency as the Schedule P data we use for much of the Line 4 calibration. The R_{CAT} elements of the RBC Formula were introduced on an "information only" basis beginning with year-end 2013 reporting and as an official element in the RBC calculation at year-end 2017.[93]

Data from a new process, particularly when collected on an exploratory basis, is subject to increased risk of quality issues.

[93] NAIC Center for Insurance Policy and Research (CIPR), August 2017 Newsletter

This is the first time we are using this data. Certain features of the data are unexpected but may become clearer over time.

We identify some specific data quality matters in the following sections.

Is the Cat Data Set Representative of the Total Calibration Data Set—Number of Data Points?

We obtain Cat Data from confidential RBC Filings. We obtain the Academy calibration data from Annual Statements for Ten-Year LOBs and RBC Filing data for Two-Year LOBs.

It would be optimal if the data from the Annual Statement and RBC Filing sources were the same for AYs 2004-2017, the years the data sets have in common. In practice, however, not all companies make RBC Filings, and reasonableness reviews eliminate some catastrophe data points.

Exhibit A7-2 compares the number of data points in the Academy calibration and the number of data points in the RBC catastrophe data. The counts are close for Two-Year LOBs I-SP and J-APD, where both the Academy calibration data and the Cat Data come from RBC Filings. The counts also closely match for the LOBs with the fewest data points, M-Intl, N-Re-Prop, and O-Re-Liab. Without access to RBC data by company, we cannot identify the reasons for the larger differences in the other LOBs.

Exhibit A7-2
Matching Data Points in Academy Catastrophe Adjustment Calibrations
AYs 2004-2017

(1)	(2)	(3)	(4)	(5)
LOB	# Data Points		% Overlap: (3)/(2)	Difference
	In Academy Calibration	In Cat Data		
A-HO	5,447	4,924	90.4%	9.6%
E-CMP	3,827	3,441	89.9%	10.1%
G-SL	839	708	84.4%	15.6%
I-SP	4,830	4,735	98.0%	2.0%
J-APD	4,839	4,689	96.9%	3.1%
M-Intl	110	109	99.1%	0.9%
N-Re-Prop	435	427	98.2%	1.8%
O-Re-Liab	366	357	97.5%	2.5%
R-PL	1,235	1,119	90.6%	9.4%

Is the Cat Data Set Representative of Total Calibration Data Set—87.5th Percentile LRs?

In the Cat Data, adding U.S. Catastrophe Losses, Non-U.S. Catastrophe Losses, and Non-Catastrophe Losses, we obtain Total Losses. We compare indicated risk charges using the Total

Losses from Cat Data to indicated risk charges using Academy calibration data. Exhibit A7-3 shows the following:

- Column 2 shows the indicated undiscounted risk charge based on the AY 2004-2017 portion of the Academy calibration data set. (Exhibit A7-2 column 2, above, shows the number of data points in this data set, by LOB.)
- Column 3 shows the indicated undiscounted risk charge based on the Cat Data for the data points in both the Academy calibration data set and the Cat Data. (Exhibit A7-2 column 3 shows the number of data points in this data set.)
- Column 4 shows the indicated undiscounted risk charge based on the Academy calibration data for the data points in both the Academy calibration data set and the Cat Data.

Exhibit A7-2 (column 2 versus column 3) shows that the number of data points underlying Exhibit A7-3 column 2 differs from those underlying Exhibit A7-3 columns 3 and 4. Therefore, it is not surprising that the indicated undiscounted risk charge in Exhibit A7-3 column 2 does not equal the indicated undiscounted risk charge in Exhibit A7-3 columns 3 and 4.

Surprisingly, the indicated undiscounted risk charges shown in columns 3 and 4 are not the same, even though they are based on the same AY/LOB/company-pool data points. The differences between columns 3 and 4 are large for some LOBs. We cannot evaluate the reasons for the difference since the Cat Data is confidential.

Exhibit A7-3
Comparison of 87.5th Percentile Undiscounted Risk Charges

Indicated Undiscounted Risk Charge (2004-2017 Data)			
(1)	In AAA Calib Data	In AAA Calib Data and in Cat Data	
	(2)	(3)	(4)
LOB	Line 4 Calib	Using Cat Data	Using Calib Data
A-HO	20.1%	20.4%	19.6%
E-CMP	17.6%	18.9%	16.0%
G-SL	20.3%	29.8%	20.0%
I-SP	11.5%	12.9%	11.3%
J-APD	5.5%	8.0%	5.5%
M-Intl	121.6%	136.0%	124.4%
N-Re-Prop	40.7%	48.8%	40.7%
O-Re-Liab	14.5%	27.2%	15.0%
R-PL	34.4%	33.8%	35.9%

Time period

The indicated catastrophe adjustment is based on data from AYs 2004-2017, while the overall indicated risk factors that require adjustment are based on data from AYs 1988-2017.

The catastrophe adjustment depends on the effect of catastrophe losses on the 87.5th percentile LR during the experience period. That adjustment might differ for the 2004-2017 period, for which we have Cat Data (catastrophe calibration period), compared to the 1988-2017 period used for overall risk charge calibration.[94]

US Earthquake

The largest earthquake in the 1988-2017 period is the January 1994 Northridge, California, earthquake (insured loss of $15 billion at that time and over $30 billion if expressed in 2023 dollars).[95] This is part of the overall data but not part of the catastrophe calibration period.

During the 2004-2017 catastrophe calibration period the two largest U.S. earthquakes (based on insured losses) were the August 2014 South Napa, California, earthquake (insured loss of $200 million) and the August 2011 Virginia/Washington D.C. earthquake (insured loss of $100 million).

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[94] Cat Data also includes non-U.S. hurricanes and earthquakes. There have been numerous major non-U.S. earthquakes in 2004-2017, but we have not compared the effects on US (re)insurers of non-U.S. hurricanes and earthquakes during the two time periods, 1988-2003 and 2004-2017.

[95] Insured loss amounts of these US earthquakes was retrieved from the Insurance Information Institute, "A Firm Foundation: How Insurance Supports the Economy (Earthquakes)," on August 1, 2023.

Since the overall calibration loss data includes Northridge and the catastrophe calibration period includes only a few smaller U.S. earthquakes, the earthquake element in the catastrophe adjustments may be too small.

US Hurricanes

Both the 1988-2003 period and the catastrophe calibration period include numerous major U.S. hurricanes.

Hurricanes affect many more company-pool AY data points than earthquakes, and the number of hurricanes per year is higher in the 2004-2017 period than in the earlier 1988-2003 period.[96] To the extent that catastrophes drive risk charges, and if all else were equal, the 87.5th percentile LR for 2004-2017 would be higher than the 87.5th percentile for the earlier period.

Comparing 1988-2003 to 2004-2017

To test this hypothesis, Columns 2-4 in Exhibit A7-4 below show the 87.5th percentile PV indicated risk charge[97] for the 1988-2003 period for which we have no catastrophe experience, for the 2004-2017 period, where we have catastrophe experience, and for the total 1988-2017 period. Column 5 shows the ratio of column 4 to column 3. The values are nearly all greater than 1.0, showing that, contrary to that hypothesis, the 87.5th percentile PV LRs are higher in the earlier period than in the more recent period.

[96] At "Continental United States Hurricane Impacts/Landfalls, 1851-2022," the National Oceanic and Atmospheric Agency reports 1.3 hurricane landfalls per year in 1988-2003 and 1.8 hurricane landfalls per year in 2004-2017. NOAA and other sources show a similar relationship for tropical storm landfalls.

[97] In Section 5, we show that, for all-lines combined, earlier periods had higher 87.5th percentile loss ratios than more recent years. We also observed that the pattern is less evident on a PV basis than on an undiscounted basis. Therefore, we use PV LRs for this comparison.

Exhibit A7-4
87.5th Percentile PV LR by LOB

(1)	(2)	(3)	(4)	(5)
	87.5th PV LR by Time Period			
LOB	1988-03	2004-17	1988-17	(4)/(3)
A-HO	0.937	0.893	0.924	1.034
E-CMP	0.834	0.789	0.817	1.035
G-SL	0.880	0.831	0.862	1.038
I-SP	0.790	0.804	0.793	0.987
J-APD	0.826	0.802	0.822	1.025
M-Intl	1.489	1.720	1.495	0.870
N-Re-Prop	1.135	1.101	1.128	1.025
O-Re-Liab	1.009	0.745	0.929	1.247
R-PL	1.011	0.837	0.936	1.119

However, for the LOBs with larger catastrophe adjustments, the differences in the different time periods are generally small, e.g., under 1.05.[98] Therefore, we do not adjust for the difference in time periods.

Catastrophe experience as a share of total experience

To obtain further insight into the distribution of catastrophe losses, we calculate the ratio of the total catastrophe losses to the total losses for each LOB. Column 4 in Exhibit A7-5, below, shows that percentage. We compare that to the ratio of the 87.5th percentile catastrophe losses to the 87.5th percentile total losses, shown in column 3 in Exhibit A7-5.

Except for M-Intl and R-PL, the ratio of catastrophe losses to total losses is greater than the ratio of the 87.5th percentile catastrophe losses to the 87.5th percentile total losses. We understand this to mean that while catastrophes are important, other factors, combined, are more important in driving the risk charges. While that might seem surprising, we note that the total LRs are net of reinsurance, and company catastrophe reinsurance programs likely mitigate the effect of major events on the company net LRs and reduce the role of catastrophes in driving the total risk by LOB.

[98] The LOBs with column 5 of Exhibit A7-4 greater than 1.05/less than .95 are M-Intl, with low credibility based on the small number of data points, O-Re-Liab with a very small adjustment, and R-PL, which we expect would have had zero catastrophe losses.

Exhibit A7-5
Catastrophe Share of Total Losses

(1)	(2)	(3)	(4)
	col 5	col 5/col 3	Cat Data
LOB	87.5th Cat LR	87.5th Cat LR/ 87.5th Total LR	Cat $/ Total $
A-HO	2.6%	2.8%	4.9%
E-CMP	1.6%	2.0%	4.6%
G-SL	4.3%	4.5%	5.1%
I-SP	3.4%	4.1%	10.5%
J-APD	0.6%	0.7%	1.5%
M-Intl	32.8%	17.1%	15.9%
N-Re-Prop	25.9%	21.2%	26.6%
O-Re-Liab	0.4%	0.4%	0.9%
R-PL	0.3%	0.3%	0.0%

Notes:
Column 2, 87.5th Cat LR = 87.5th Total LR – 87.5th LR excluding cats=Indicated Cat Adjustment.
Exhibit A7-5 column 2 is equal to Table 7.1 column 5.
Exhibit A7-5 column 3 = The ratio of Table 7.1 column 5 to Table 7.1 column 3.

Experience at higher percentiles

Our analysis of indicated risk factors includes the development of indicated risk factors at safety levels of 87.5th percentile, 90th percentile, and 95th percentile.

Therefore, we calculate indicated catastrophe adjustments at those percentiles. We show the results in Exhibit A7-6 below.

- Column 2 is the raw catastrophe adjustment, equal to the values in Section 7, Table 7-1, column 5.
- Columns 3 and 4 give the corresponding information at safety levels of 90% and 95%.
- Column 5 is the indicated undiscounted risk charge using the Cat Data set, catastrophe losses plus non-catastrophe losses, equal to the values in Section 7, Table 7-1, column 7.
- Columns 6 and 7 give the corresponding information at safety levels of 90% and 95%.
- Column 8 is the ratio of the indicated catastrophe adjustment to the total undiscounted risk charge, equal to the values in Section 7, Table 7-1, column 8, when the selected catastrophe adjustment equals the raw indicated catastrophe adjustment.
- Columns 9 and 10 give the corresponding information at safety levels of 90% and 95%.

As must be the case for all LOBs, the indicated risk charges increase as the safety level increases (columns 5-7).

For most LOBs, the raw catastrophe adjustments increase as the safety level increases (columns 2-4). That is not the case, though, for J-APD and N-Re-Prop, where the adjustment is

level or nearly level, or for M-Intl, O-Re-Liab, and R-PL, where the adjustment decreases as the safety level increases.

The decreasing indicated adjustment for M-Intl is unusual. It suggests a loss distribution in which catastrophe losses are represented in the worst 12.5% of LRs but are less represented in the worst 10% or 5% of LRs, where adverse LRs are, apparently, driven by factors other than catastrophes.

The decrease in R-PL with a negative indicated catastrophe adjustment suggests data issues, which is not surprising given that we expect no catastrophe losses for R-PL.

Exhibit A7-6
Catastrophe Adjustment at Higher Percentiles

(1)	Raw Cat Adjustment by %-ile			Indicated Risk Charge			Cat/Gross Risk Charge		
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
LOB	87.5th Percentile	90th Percentile	95th Percentile	87.5th Percentile	90th Percentile	95th Percentile	87.5th Percentile	90th Percentile	95th Percentile
A-HO	2.6%	3.5%	4.6%	20.4%	25.4%	41.4%	12.7%	13.8%	11.1%
E-CMP	1.6%	2.4%	4.8%	18.9%	23.9%	40.9%	8.6%	10.1%	11.8%
G-SL	4.3%	3.6%	11.9%	29.8%	36.6%	72.1%	14.4%	9.7%	16.4%
I-SP	3.4%	4.6%	7.8%	12.9%	18.6%	41.5%	26.3%	24.8%	18.8%
J-APD	0.6%	0.6%	0.6%	8.0%	11.3%	23.0%	7.5%	5.0%	2.6%
M-Intl	32.8%	5.6%	0.0%	136.0%	150.0%	303.0%	24.1%	3.7%	0.0%
N-Re-Prop	25.9%	22.9%	26.3%	48.8%	59.6%	99.1%	53.0%	38.4%	26.5%
O-Re-Liab	0.4%	0.3%	0.0%	27.2%	36.2%	69.1%	1.3%	0.9%	0.0%
R-PL	0.3%	0.0%	-0.7%	33.8%	42.5%	85.4%	0.8%	0.0%	-0.8%

Selected Catastrophe Adjustments

The data issues we identify above are important. In principle, we might limit our reliance on the indications from Cat Data by giving some weight to the current catastrophe adjustments. However, we have limited information on the origin of the current catastrophe adjustments. Those factors are likely subject to the same or greater data limitations than Cat Data.

The data issues identified may be resolved with additional data and/or further explored in future calibration studies.

At this time, though, since we have no data source better than Cat Data for catastrophe adjustment purposes, we rely primarily on the indicated catastrophe adjustments from that data.

Exhibit A7-7 shows our selected catastrophe adjustments at the three safety levels presented in this report.

Exhibit A7-7
Selected Catastrophe Adjustments

(1)	(2)	(3)	(4)
LOB	87.5th Percentile	90th Percentile	95th Percentile
A-HO	2.6%	3.5%	4.6%
E-CMP	1.6%	2.4%	4.8%
G-SL	4.3%	3.6%	11.9%
I-SP	3.4%	4.6%	7.8%
J-APD	0.6%	0.6%	0.6%
M-Intl	*15.0%*	*0.0%*	*0.0%*
N-Re-Prop	25.9%	25.9%	25.9%
O-Re-Liab	0.4%	0.3%	0.0%
R-PL	*0.0%*	*0.0%*	*0.0%*

We select the raw catastrophe adjustment indications except for M-Intl, N-Re-Prop, and R-PL.

For N-Re-Prop, we select the same adjustment for all safety levels as the number of data points is relatively low. We select a zero adjustment for R-PL, as we do not expect catastrophe exposure and where the raw catastrophe adjustment indications at higher percentile levels suggest data issues.

For M-Intl, we select an adjustment lower than the raw catastrophe adjustment indications because, compared to other LOBs, Intl data has:

- Low credibility (Exhibit A7-1),
- An unusual ratio of 1988-2003 risk charge to 2004-2017 risk charge (Exhibit A7-4),
- An unusual relationship between the average catastrophe share of losses as a percentage of total losses and the 87.5th percentile catastrophe share of losses as a percentage of the 87.5th percentile total losses (Exhibit A7-5), and
- It has a sharply declining catastrophe adjustment by safety level (Exhibit A7-6).

R_{CAT} Instructions

We have two observations regarding the RBC forms and calculations:

- For J-APD, the Lines 1 to 3 calculations of PR018 (which compare the company historical loss ratio to the industry historical loss ratio) use total losses, including catastrophe losses. For other LOBs with catastrophe adjustments, the calculations in Lines 1 to 3 use losses excluding the company catastrophe losses.

  As the data shows catastrophe losses for J-APD, it might be appropriate to make the J-APD calculations for Lines 1 to 3 of PR018 the same as for the other LOBs with catastrophe exposure.

- A key assumption in our analysis is that the hurricane and earthquake modeling includes reasonable provisions for all losses of the types that are reported in the

catastrophe experience. The NAIC should consider the extent to which the modeling is sufficiently comprehensive.

- In the section above, "Is the Cat Data Set Representative of Total Calibration Data Set-87.5th Percentile LRs?," we observed unexpected differences between Annual Statement data and RBC data. That may be an issue related to the early-year use of the RBC forms PR101, etc., for reporting historical hurricane and earthquake loss experience. The NAIC should consider whether differences can be investigated.

19.APPENDIX 8—Type of Company: Background

Definition

The NAIC impact model assigns each company to one of six categories—Personal Lines, Commercial Lines, Medical Professional Liability, Reinsurance, Workers Compensation, or Not Otherwise Classified ('Other' or 'NOC') by determining the amount of net written premium plus loss and LAE reserves (NWP + Reserves) for each of the six categories shown in Exhibit A8-1 below and then determining the category with the highest amount of premium plus reserves.

Exhibit A8-1
Key LOBs for Type of Company Categorization

Schedule P Line	Category		Schedule P Line	Category
(1) HO	Personal Lines		(12) APD	Personal Lines
(2) PPA	Personal Lines		(10) Fid/Sur	NOC
(3) CA	Commercial Lines		(13) Other	NOC
(4) WC	Workers Compensation		(15) Intl	NOC
(5) CMP	Commercial Lines		(16) Re-Prop	Reinsurance
(6) MPL-O	Medical Professional		(17) Re-Liab.	Reinsurance
(7) MPL-C	Medical Professional		(18) PL	Commercial Lines
(8) SL	NOC		(14) FG/MG	NOC
(9) OL	Commercial Lines		(19) Wrnty	NOC
(11) SP	Commercial Lines			

LOB Share With Each Type of Company

Exhibit A8-2 shows the proportion of NWP+Reserves LOB within each Type of Company category, from 2019 RBC Filings.

Exhibit A8-2
Distribution of NWP + Reserves by LOB Within Each Type of Company

LOB\Category	Commercial	Med Mal	NOC	Personal	Reinsurer	Workers Comp	Total
HF	6%	0%	0%	17%	2%	2%	10%
PPA	6%	0%	0%	45%	2%	4%	22%
CA	8%	0%	0%	3%	2%	4%	5%
WC	16%	1%	0%	2%	2%	73%	15%
CMP	10%	0%	0%	3%	1%	6%	6%
MM Occ	0%	24%	0%	1%	0%	0%	1%
MM CM	1%	72%	0%	1%	0%	0%	2%
SL	2%	0%	20%	0%	2%	0%	1%
OL	30%	2%	22%	3%	8%	6%	16%
FID/SUR	1%	0%	38%	0%	0%	1%	1%
SP	9%	0%	2%	2%	6%	1%	5%
APD	4%	0%	0%	18%	1%	2%	9%
Other	1%	0%	13%	0%	0%	0%	1%
Fin/Mortgage	0%	0%	0%	0%	0%	0%	0%
INTL	0%	0%	0%	0%	3%	0%	0%
Rein (Prop and	1%	0%	0%	2%	21%	0%	2%
Rein (LiAI)	3%	1%	0%	2%	49%	1%	3%
PL	2%	0%	0%	0%	0%	1%	1%
WAR	0%	0%	4%	0%	0%	0%	0%
Total %	100%	100%	100%	100%	100%	100%	100%
Total - $	612,343,230	21,289,449	7,851,892	524,169,525	14,841,788	119,683,083	1,300,178,967

Source: 2019 RBC Filings.

The shaded elements are the three LOBs with the largest volume within the Type of Business category. For example, the main LOBs within the category NOC are K-Fid/Sur, H-OL, and G-SL. The Medical Professional Type of Company is predominantly F2-MPL-C.

20.APPENDIX 9—Cat Data Collection Instructions

This appendix shows the Committee's instructions to the Regulators to collect blinded data for Ten-Year LOBs for catastrophe adjustment purposes.

We developed these instructions for Ten-Year LOBs. For Two-Year LOBs, the NAIC followed the same method.

INSTRUCTIONS PROVIDED TO REGULATORS

Abbreviations/Short Descriptions:

We use the following abbreviations/short descriptions in this write-up:

- "AY" represents accident year.
- "ASY" represents annual statement year.
- "IL" or "incurred loss" represents incurred loss and loss adjustment expenses net of reinsurance.
- "NEP" or "premium" represents earned premium net of reinsurance.
- "AS" means Annual Statement, as in AS NEP = NEP from Annual Statement data.
- "Ten-Year LOBs" are LOBs for which Schedule P contains information on the most recent 10 AYs.
- "Two-Year LOBs" are LOBs for which Schedule P contains information on the most recent 2 AYs.

Files:

- "AAA Calib Data" = the file "AAA Calib Data (05.28.21).xlsx"
    - This is the AAA P/C RBC Committee's base data for calibration of Ten-Year LOBs.
    - It includes data for Ten-Year LOBs only. It is drawn from Schedule P.
    - It reflects pooling.
    - It reflects all the filtering used in Academy Line 4 calibration (as described in the March 2021 AAA P/C RBC Committee paper).
    - Each record in this file contains the following fields: LOB/company-pool- code/ASY/AY/NEP/IL.
- "RBC Calib Data" = the file prepared by Sak-man Luk with confidential RBC data for Two-Year LOBs.
    - This is the AAA P/C RBC Committee's base data for calibration of Two-Year LOBs; calibration is done by regulators due to data confidentiality,
    - It includes data for Two-Year LOBs only. It is drawn from RBC Filings.
    - It reflects pooling.
    - It reflects all the filtering used in Academy Line 4 calibration.
    - Each record in this file contains the following fields: LOB/company-pool- code/ASY/AY/NEP/IL.

- "Cat Data" = the file with confidential cat experience and non-cat data from RBC forms PR101, … etc. For each LOB, Company, AY, and ASY, it includes the following fields: U.S. CAT IL/Non-US CAT IL/Non-CAT IL/NEP
- "Pooling Map" = workbook showing the conversion of company-code/ASYs to pool-code/ASYs
    - File name = "Pooling- 1984-2017 April 30 2019-to AY.xlsx".
    - Each record in this file has fields Company Code ("CoCode")/ASY/Pool Code

Algorithm: Consolidate records in "Cat Data" as follows:

1. Select the most mature valuation of IL/NEP for each company, AY, LOB. (Maturity = Annual Statement Year, a.k.a. Report Year, minus AY plus 1)

2. Using the file "Pooling Map," add a new "company-pool" field to each of the records in "Cat Data" selected in step #1.
   The company-pool field is the pool code (from "Pooling Map") if the ASY/company indicates the record is part of a pool, otherwise the company-pool field is the company code.

3. Sum the NEP and IL amounts from step 2, by company-pool, to produce a total US Cat IL/Non-US CAT IL/Non-CAT IL/NEP for each company-pool/AY/LOB.

For Ten-Year LOBs:

4. Using "Cat Data" output, after applying the above algorithm, and using the "AAA Calib Data," determine which records are in one or both of those two files. Specifically:

5. In "Cat Data"
    a. Add a field "Match" = "Yes/No," to indicate whether the "Cat Data" LOB/AY/Company-Pool-code record has a matching LOB/AY/Company-Pool-code in the "AAA Calib Data" file.
    b. Add two fields for Annual Statement NEP and IL, abbreviated to AS NEP and AS IL:
        - If there is a match (5a=Yes), set the AS NEP and AS IL equal to those from "AAA Calib Data" (The NEPs should be the same; the Ils might differ because of different development age).
        - If there is no match (5a=No), set AS NEP = "NA" and AS IL = "NA".

6. In "AAA Calib Data":
    a. Add a field "Yes/No," to indicate whether the "AAA Calib Data" LOB/AY/Company-Pool-code record has a matching LOB/AY/Company-Pool-code in the "Cat Data" file.

7. Summarize the following record counts, for AYs 2004 through 2017 in total by LOB, and by individual AY within LOB for each individual AY from 2004 through 2017:
    a. From "Cat Data":
        - The total number of records
        - The number of records in "Cat Data" and in "AAA Calib Data"
        - The number of records in the "Cat Data" only (in other words, in the "Cat Data" but not in the "AAA Calib Data")
    b. From the "AAA Calib Data":
        - The total number of records
        - The number of records in "AAA Calib Data" and in "Cat Data"
        - The number of records in the "AAA Calib Data" only (in other words, in the "AAA Calib Data" but not in the "Cat Data")

    Table 1, attached, shows a possible format for the record count summaries described in step 7.

8. Similar to step 7, summarize NEP for AYs 2004 through 2017 in total by LOB, and by individual AY within LOB for each individual AY from 2004 through 2017.

    Table 2, attached, shows a possible format for the NEP summaries described in step 8.

Table 3, attached, shows a possible format for the 87.5th percentile results described below in steps 9, 10, and 11.

9. In "Cat Data," for each LOB, calculate the 87.5th percentile of the Non-CAT LRs over all accident years (2004 through 2017) for the companies/pools in both data sets (counted in column 2 of Table 1).
    - Definition: Non-CAT LR = Non-CAT IL divided by NEP.
    - Enter the 87.5th percentile results into column 1 of Table 3.

10. In "Cat Data," for each LOB, calculate the 87.5th percentile of the total LRs over all accident years (2004 through 2017) for the companies/pools in both data sets (counted in column 2 of Table 1).
    - Definition: total LR = Total IL divided by NEP.
    - Note that Total IL = U.S. Cat IL + Non-U.S. Cat IL + Non-CAT IL.
    - Enter the 87.5th percentile results into column 2 of Table 3.

11. In "AAA Calib Data," for each LOB, calculate the 87.5th percentile of the LRs over all accident years (2004 through 2017) for the companies/pools in both data sets (counted in column 5 of Table 1).

- Definition: LR = IL divided by NEP.
- Enter the 87.5th percentile results into column 3 of Table 3.

Note that there are 32,248 records in the "AAA Calib Data" for AY 2004 through AY 2017.

We expect that the "Cat Data" file will be larger, perhaps twice the number of data points in "AAA Calib Data". This is because the "AAA Calib Data" only includes records which have successfully passed all filtering (in other words, it excludes data from companies with small premium, minor lines, etc.).

Table 1
(Refer to Step 7) Sample Summary of Record Counts—Ten-Year LOBs

Table 1: Record Counts: Refer to Step 7 for Instructions							
		Ten-Year LOBs					
Data Set >>		"Cat Data"			"AAA Calib Data"		
Column Number >>		(1)	(2)	(3)	(4)	(5)	(6)
				3=1-2			6=4-5
LOB	AY	# in Cat Data: Total	# in Cat Data and in AAA Calib Data	# in Cat Data and NOT in AAA Calib Data	# in AAA Calib Data: Total	# in AAA Calib Data and in Cat data	# in AAA Calib Data and NOT in Cat data
all	2004-2017						
A	2004-2017						
B	2004-2017						
C	2004-2017						
...	2004-2017						
R	2004-2017						
A	2004						
A	2005						
A	2006						
A	2007						
A	2008						
A	2009						
A	2010						
A	2011						
A	2012						
A	2013						
A	2014						
A	2015						
A	2016						
A	2017						
B	2004						
...	...						

Table 2
(Refer to Step 8) Sample Summary of NEP—Ten-Year LOBs

Table 2: NEP Summary: Refer to Step 8 for Instructions							
		Ten-Year LOBs					
Data Set >>		"Cat Data"			"AAA Calib Data"		
Column Number >>		(1)	(2)	(3)	(4)	(5)	(6)
				3=1-2			6=4-5
LOB	AY	NEP in Cat Data: Total	NEP in Cat Data and in AAA Calib Data	NEP in Cat Data and NOT in AAA Calib Data	NEP in AAA Calib Data: Total	NEP in AAA Calib Data and in Cat data	NEP in AAA Calib Data and NOT in Cat data
all	2004-2017						
A	2004-2017						
B	2004-2017						
C	2004-2017						
...	2004-2017						
R	2004-2017						
A	2004						
A	2005						
A	2006						
A	2007						
A	2008						
A	2009						
A	2010						
A	2011						
A	2012						
A	2013						
A	2014						
A	2015						
A	2016						
A	2017						
B	2004						
...	...						

Table 3
(Refer to steps 9, 10, and 11) 87.5 percentile results

		Table 3: 87.5 Percentile Results		
		Ten-Year LOBs		
Column Number >>		(1)	(2)	(3)
		Refer to Step 9	Refer to Step 10	Refer to Step 11
LOB	AY	Cat Data and in AAA Calib Data Non-CAT loss ratio	Cat Data and in AAA Calib Data total loss ratio	AAA Calib Data and in Cat Data loss ratio
A	2004-2017			
B	2004-2017			
C	2004-2017			
...	2004-2017			
R	2004-2017			

21. GLOSSARY

Term	Definition/Description
2010 Method	The payment pattern method used the last time IIAs were updated in 2010, using data through 2008.
40-year Runoff Payment Pattern	Payment pattern constructed in this Report, extending to as many as 40 years of loss payments, as indicated by the data.
40-year Truncated Payment Pattern	40-year runoff payment patterns but limited to 10 years.
ACL	Authorized Control Level required capital from the RBC Formula; 50% of CAL.
Age	Development age: • For an AY, age 1 refers to payments, reserves, or incurred amounts at the end of the AY; • For reserves, age 1 refers to the initial reserve, i.e., the reserve at the year ending at the valuation date, usually the end of the least mature AY in that reserve.
AY	Accident year
CAL	Company Action Level, required capital value from the RBC Formula.
Cat Data	Confidential RBC data from RBC forms PR101 - PR122, one form for each LOB. Cat Data in those forms provides the following fields for each LOB, company, and AY in each RBC Filing year: U.S. Catastrophe Incurred Losses, Non-US Catastrophe Incurred Losses, Non-Catastrophe Incurred Losses, Net Earned Premium.
Cat losses	Losses from specified U.S.-Hurricane, U.S.-Earthquake, Non-U.S. Hurricane, Non-U.S. Earthquake, including designated tropical storms (in the hurricane category).
Catastrophe calibration period	The 2004-2017 period, for which we have Cat Data.
Committee	American Academy of Actuaries Property and Casualty Risk-Based Capital Committee
Current Factors	Factors in the 2022 RBC Formula
Expense Ratio	2017 industry net expenses divided net earned premium, from the 2017 Insurance Expense Exhibit, by LOB.
IIA	Investment Income Adjustment; Also referred to as Line 7/8.
Initial reserve	The reserve at the end of the selected valuation date.
Initial Reserve Year	The year ending at the selected valuation date. This is usually the year of the least mature AY in the reserve, i.e., the initial reserve year for the reserves as of December 31, 1995, is 1995.
Interest Rate	Per annum interest rate, U.S. Treasuries, unless otherwise specified.
LDF	Loss development factor
Line 4 Factor	Risk factor, line in RBC Formula PR017, PR018.
Line 7/8 Factor	IIA, row in RBC Formula, PR017 (Line 8) and PR018 (Line 7).
LOB	Line of Business

Term	Definition/Description
LR	Loss Ratio, loss and all loss adjustment expenses divided by earned premium, net of reinsurance.
NOC	"NOC," standing for Not Otherwise Classified, means companies for which the portion of net written premium plus loss reserves is greatest for the sum of the following LOBs: G-SL, K-Fid/Sur, L-Other, M-Intl, or S-FG/MG.
PR017	Page of the P&C RBC formula that contains calculations for R4 UW Risk—Reserves.
PR018	Page of the P&C RBC formula that contains calculations for R5 UW Risk—Net Written Premium.
Premium IIA	Investment Income Adjustment for premium risk. Line 7 on page PR0018.
Premium risk charge	Premium risk charge for LOBs generally.
Premium risk charge $_{LOB}$	Simplified: Premium Risk Factor $_{LOB}$ * IIA $_{LOB}$ + Industry Average Expense Ratio $_{LOB}$ - 100%
Premium risk factor	Line 4 in RBC Formula PR018
PV indicated risk charge	The 87.5 percentile of discounted data points (RRRs or LR), and, for premium risk, the industry expense ratio by line of business minus 100%.
PV Method	Calibrate Line 4 and IIAs combined, using the PV indicated risk charge.
R0	Part of the RBC Formula for Affiliated Insurance Companies and Misc. Other Amounts.
R2	Part of the RBC formula for Equity Assets.
R4 or R4- UW Risk—Reserves	Part of the RBC Formula for UW Risk—Reserves RBC on page PR017.
R5 or R5 - UW Risk—Net Written Premium	Part of the RBC Formula for UW Risk—Net Written premium RBC page PR018.
RBC	Risk-Based Capital
RBC Formula	References relate to the 2022 RBC Formula.
R_{CAT}	Part of the RBC Formula that accounts for earthquake and hurricane premium risk.
Reported Risk Development Horizon or Risk Development Horizon	The window of available data, the 10 years provided in Schedule P and RBC data.
Reserve IIA	Investment Income Adjustment for reserve risk. Line 8 on page PR0017.
Reserve Risk Charge	Reserve risk charge for LOBs generally.
Reserve Risk Charge $_{LOB}$	Simplified: (1.0 + Reserve Risk Factor $_{LOB}$) * IIA $_{LOB}$ - 100%
Reserve Risk Factor	Line 4 in RBC Formula PR017

Term	Definition/Description
Risk Development Horizon Adjustment (RDHA)	The anticipated increase in indicated risk charges with increasing age of data points.
RRR	Reserve Runoff Ratio
Ten-Year LOBs	LOBs for which Schedule P contains information on the most recent 10 AYs.
TAC	Total Adjusted Capital as defined in the RBC Formula.
Two-Year LOBs	LOBs for which Schedule P contains information on the most recent 2 AYs.
Undiscounted Premium Risk Charge	The premium risk charge before applying the IIAs. Calculated as follows: Undiscounted Premium Risk Charge $_{LOB}$ = Premium Risk Factor $_{LOB}$ + Industry Average Expense Ratio $_{LOB}$ - 100%.
Undiscounted Reserve Risk Charge	The reserve risk charge before applying the IIAs, calculated as follows: Undiscounted Reserve Risk Charge $_{LOB}$ = Reserve Risk Factor$_{LOB.}$
Updated Data	Data through 2017
Working Group	National Association of Insurance Commissioners' Property and Casualty Risk-Based Capital Working Group

Exhibit A12-2
LOB Descriptions

(1)	(2)	(3)	(4)
Schedule P LOB Name	**RBC LOB Name (PR017 and PR018)**	**Schedule P Letter Code**	**Short Label**
Homeowners & Farmowners	H/F	A	HO
Private Passenger Auto Liability	PPA	B	PPA
Commercial Auto Liability	CA	C	CA
Workers' Compensation	WC	D	WC
Commercial Multiple Peril	CMP	E	CMP
Medical Professional Liability (Occurrence)	MPL OCCURRENCE	F1	MPL-O
Medical Professional Liability (Claims Made)	MPL CLMS MADE	F2	MPL-C
Special Liability (Note 1)	SL	G	SL
Other Liability: Claims Made and Other Liability: Occurrence	OL	H	OL
Special Property (Note 2)	SPECIAL PROPERTY	I	SP
Auto Physical Damage	AUTO PHYSICAL DAMAGE	J	APD
Fidelity & Surety	FIDELITY/SURETY	K	Fid/Sur
Other (Inc Credit, Accident & Health) (Note 3)	OTHER (INCLUDE CREDIT, A&H)	L	Other
International (Note 4)	INTL	M	Intl
Reinsurance: Nonproportional Assumed Financial and Reinsurance: Nonproportional Assumed Property	REIN PROPERTY & FINANCIAL LINES	N	Re-Prop
Reinsurance: Nonproportional Assumed Liability	REIN LIABILITY	O	Re-Liab
Product Liability: Claims Made and Product Liability: Occurrence	PL	R	PL
Financial & Mortgage Guaranty	FINANCIAL/MORTGAGE GUARANTY	S	FG/MG
Warranty	WARRANTY	T	Wrnty

The 19 RBC LOBs are a subset of the 22 Schedule P LOBs, which is a subset of the 45 Statutory Page 14 LOBs, plus write-in LOBs in the "Underwriting and Investment Exhibit Part 1 Premium Earned" section of the Annual Statement

Note 1: Special Liability consists of Statutory Page 14 LOBs: Ocean Marine, Aircraft (all perils), and Boiler and Machinery (Statutory Page 14 LOBs 8, 22, and 27).

Note 2: Special Property consists of Statutory Page 14 LOBs: Fire, Allied Lines, Inland Marine, Earthquake, and Burglary and Theft (Statutory Page 14 LOBs 1, 2, 9,12, and 26).

Note 3: Other (Inc Credit, Accident & Health) consists of Statutory Page 14 LOBs: Group A&H, Credit A&H (group and individual), Other A&H, and Credit (Statutory Page 14 LOBs 13, 14, 15, and 28)

Note 4: LOB International consists of non-US business that cannot be identified by Statutory Page 14 LOB in the 2017 Annual Statement.