EXTREME VALUE TECHNIQUES
PART II: VALUE PROPOSITION FOR FORTUNE 500 COMPANIES

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Extreme Value Techniques
Part II: Value Proposition for Fortune 500 Companies

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Abstract. Swiss Re's Value Proposition is basically a consulting approach in which [using Swiss Re's risk-adjusted capital (RAC) concept] an optimal self-insured retention (SIR) is determined for a particular insured. Very early on in the "Beta" product engineering process (described in *Extreme Value Techniques - Part I: Pricing High-Excess Property and Casualty Layers*), the "Beta" implementation team made sure that: (1) "Beta" standard coverages implement Swiss Re's Value Proposition for "catastrophic" (or "Beta") events and (2) that the "Beta" pricing process fully reflects Swiss Re's Value Proposition for corporate clients in the Fortune 500 group of companies. This paper describes the "Beta" (extreme value theory) implementation of Swiss Re's Value Proposition. The Oil & Petrochemicals industry is used as an example.

Keywords. Extreme value theory, peaks-over-thresholds model, generalized pareto distribution, reference dataset, risk-adjusted capital, optimal self-insured retention (SIR), value proposition, optimal alternative risk transfer solution.

Contents.

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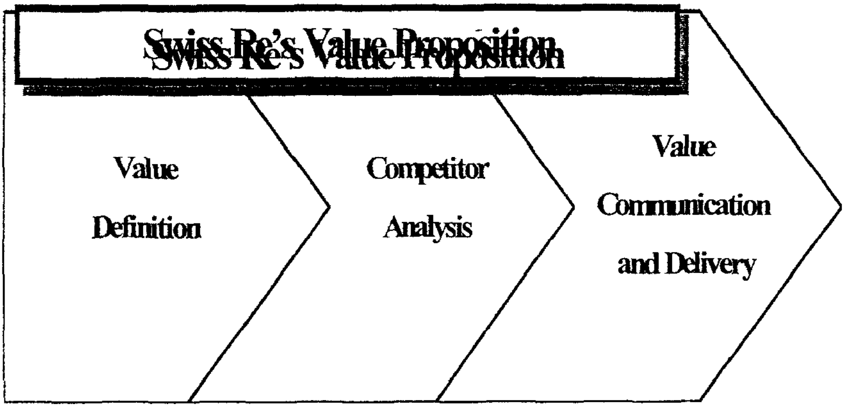
1. Introduction

The *main objectives* of Swiss Re's Value Proposition for corporate clients in the Fortune 500 group of large industrial companies are[1]:

1. ***To develop a state-of-the-art understanding of all the elements of customer value of reinsurance and - where possible - to quantify their economic benefits to the client.***

2. ***To identify areas where and how Swiss Re can differentiate its value to the customer from other reinsurers.***

3. ***To build the skills and provide the tools for Swiss Re's marketing staff in articulating the Value Proposition and in developing value-driven, efficient reinsurance programs in a more and more competitive marketplace.***



Swiss Re's Value Proposition, as outlined above, is therefore basically a consulting approach in which [using ***Swiss Re's risk-adjusted capital (RAC) concept***] an optimal self-insured retention (SIR) is determined for a particular insured. Very early on in the "Beta" product engineering process (see List and Zilch [1] for an overview), the "Beta" implementation team[2] made sure that: (1) "Beta" standard coverages implement Swiss Re's Value Proposition for "catastrophic" (or "Beta") events and (2) that the "Beta" pricing process fully reflects Swiss Re's Value Proposition for corporate clients in the Fortune 500 group of companies.

[1] For more details, see the Swiss Re publication *Insurance and Risk Capital - Swiss Re's Value Proposition* by Willy Hersberger.

[2] ETH Zurich was involved in the "Beta" product engineering process. The ETH Zurich "Beta" implementation team was lead by Prof. Dr. Hans Bühlmann, Prof. Dr. Paul Embrechts (Extreme Value Theory) and Prof. Dr. Freddy Delbaen ("Beta" Options).

2. The "Beta" Insurance Coverage

"Beta" provides multi-year, high-excess, broad form property and comprehensive general liability coverage with meaningful total limits for Fortune 500 clients in the Oil & Petrochemicals industry ("Beta" is also available in other Fortune 500 segments, its program parameters are industry-specific, however).

Coverage is provided at ***optimal layers*** within prescribed minimum and maximum per occurrence attachment points and per occurrence (i.e., each and every loss: E.E.L., see Fig. 1 below) and aggregate (AGG.) limits, split appropriately between property and casualty. These attachment points and limits are derived from the risk profiles and the needs of the insureds (Swiss Re's Value Proposition for the Oil & Petrochemicals industry).

The aggregate limits provide "Beta" ***base coverage*** for one year and over three years. Simply stated, if the base coverage is not pierced by a loss, then its full, substantial limits (USD 200M property and 100M casualty) stay in force over the entire three year "Beta" policy term.

Insureds might be concerned they would have no (or only a reduced) coverage if losses were to pierce the base coverage. Therefore, "Beta" includes a ***provision to reinstate*** all or a portion of the base coverage that is exhausted.

Lastly, the "Beta" design includes an ***option*** at the inception of the base coverage ***to extend*** its initial three year high-excess insurance coverage (i.e., the property and casualty base coverage and the provision for a single reinstatement of the base coverage) for an additional three year policy term at a predetermined price.

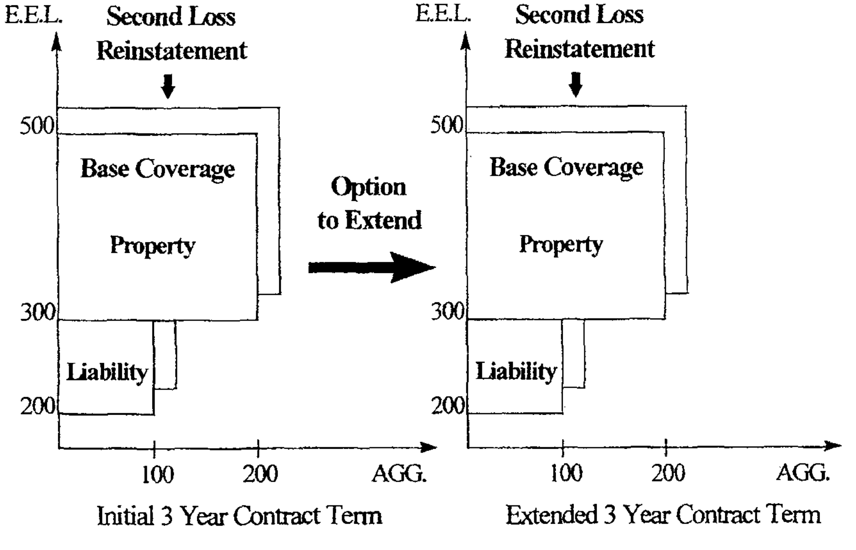


Fig. 1: The "Beta" Insurance Coverage for the Oil & Petrochemicals Industry

3. Risk Quantification and Optimal Layers

The ***risk quantification process*** leading to the above optimal "Beta" layers for multi-year (i.e., three years) high-excess property and casualty Oil & Petrochemicals industry insurance coverage in principle follows standard actuarial tradition - however with some new elements:

(I) Historical loss data are verified and adjusted. Loss adjustments (e.g., for inflation, IBNR, IBNER, etc.) are at the discretion of the experienced Oil & Petrochemicals industry underwriter. The concept of a "Beta" ***reference dataset*** is crucial in this step: the loss information taken into account represents the "Beta" target portfolio in the Oil & Petrochemicals industry over the next six years (normally on a one-year adjustment basis).

Base Period			**Extended Agreement Period**		
Threshold:	19'000'000		Threshold:	21'000'000	
Displacement:	35'556'727		Displacement:	41'161'356	
	Loss Frequency	Loss Severity		Loss Frequency	Loss Severity
Total	98	11'122'001'288	Total	102	12'960'819'507
Mean	4.9000	556'100'064	Mean	5.1000	648'040'975
Std	3.4473	821'569'868	Std	3.3388	949'459'852
Year of Loss	**Frequency of Loss**	**Severity of Loss**	**Year of Loss**	**Frequency of Loss**	**Severity of Loss**
1972	1	23'958'123	1972	1	27'734'522
1973	2	89'443'793	1973	2	103'542'371
1974	2	253'654'111	1974	3	315'282'920
1975	9	672'734'348	1975	9	778'774'099
1976	7	195'761'373	1976	7	226'618'259
1977	4	172'687'891	1977	4	199'907'820
1978	2	91'544'077	1978	3	127'240'943
1979	2	134'443'858	1979	2	155'635'571
1980	14	828'038'260	1980	14	958'557'791
1981	4	127'521'023	1981	4	147'621'524
1982	3	329'142'562	1982	5	423'822'614
1983	6	282'044'028	1983	6	326'501'218
1984	5	515'671'205	1984	5	596'953'879
1985	10	568'474'190	1985	10	658'079'934
1986	3	102'412'299	1986	3	118'555'037
1987	3	847'656'158	1987	3	981'267'960
1988	5	3'039'409'867	1988	5	3'518'496'847
1989	9	2'627'918'971	1989	9	3'042'144'699
1990	1	27'628'417	1990	1	31'983'346
1991	6	191'856'736	1991	6	222'098'153

Fig. 2a: Oil & Petrochemicals Industry Property Reference Dataset for 1997-1999 (Base Period) and 2000-2002 (Extended Agreement Period)

Remark: The Oil & Petrochemicals industry "reference datasets" presented here are of course just synthetically created examples for this paper. They are however carefully constructed and the results derived with our ***extreme value techniques*** are quite realistic. It should also be noted that the methodology presented here does not, of course, replace traditional actuarial (exposure rating) techniques. It is in fact a ***complementary*** way of pricing high-excess layers.

Base Period

Threshold:	18'000'000	
Displacement:	30'579'545	
	Loss Frequency	Loss Severity
Total	51	4'718'096'481
Mean	3.4000	314'539'765
Std	3.6801	498'226'908
Year of Loss	**Frequency of Loss**	**Severity of Loss**
1979	1	40'365'000
1980	0	0
1981	0	0
1982	0	0
1983	1	157'064'531
1984	1	109'367'952
1985	7	194'027'999
1986	2	47'776'295
1987	4	210'129'192
1988	13	1'632'203'224
1989	5	1'371'302'207
1990	4	242'645'679
1991	8	357'887'742
1992	4	323'024'661
1993	1	32'301'999

Extended Agreement Period

Threshold:	24'000'000	
Displacement:	40'701'375	
	Loss Frequency	Loss Severity
Total	51	6'279'786'416
Mean	3.4000	418'652'428
Std	3.6801	663'140'014
Year of Loss	**Frequency of Loss**	**Severity of Loss**
1979	1	53'725'815
1980	0	0
1981	0	0
1982	0	0
1983	1	209'052'891
1984	1	145'568'744
1985	7	258'251'267
1986	2	63'590'249
1987	4	279'681'955
1988	13	2'172'462'491
1989	5	1'825'203'237
1990	4	322'961'399
1991	8	476'348'584
1992	4	429'945'824
1993	1	42'993'961

Fig. 2b: Oil & Petrochemicals Industry Casualty Reference Dataset for 1997-1999 (Base Period) and 2000-2002 (Extended Agreement Period)

(2) Anticipated future developments concerning the insured or the entire Oil & Petrochemicals industry are also taken into account in order to be able to quote an overall "Beta" premium that is stable under all conceivable changes in the insured's loss generating process. Therefore, a range of ***scenarios*** specific to "Beta" for 1996 to 2001 (or a few representative annual subperiods thereof) is developed by the experienced underwriter.

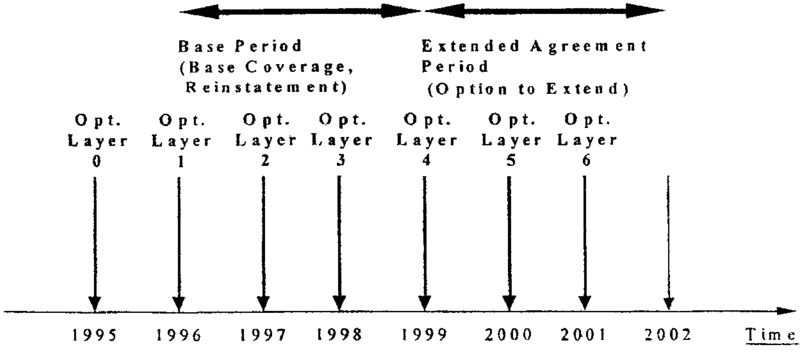


Fig. 3: Oil & Petrochemicals Industry "Beta" Scenarios

(3) The standardized and adjusted loss information (both historical and scenarios) is summarized by annual loss frequency and annual aggregate loss severity (see Fig. 2 above). Any ***trends*** in the insured's claims patterns can be recognized and carefully evaluated at this point.

(4) The individual standardized and adjusted losses are used to develop statistical/actuarial ***models*** describing ***analytical loss severity distribution functions***. The severity models provide mathematical approximation and extrapolation, at the discretion of the experienced Oil & Petrochemicals industry underwriter, of historically observed as well as anticipated (scenario) loss dynamics. The "Beta" implementation team has developed and implemented a consistent and stable (with respect to small perturbations in the input data) actuarial and Value Proposition based modelling approach for "Beta" high-excess property and casualty layers. This new methodology is based on ***Extreme Value Theory (Peaks-Over-Thresholds Model***[3]) and fits a ***generalized Pareto distribution***[4] to the ***exceedances of a data-specific threshold*** (see Fig. 2 above and Fig. 4 below). Maximum Likelihood Estimation (MLE) and the corresponding Kolmogorov-Smirnov (KS) goodness-of-fit test are applied to

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[3] It has to be noted that ***claims histories are usually incomplete***, i.e., only losses in excess of a so-called ***displacement*** δ are reported. Let therefore (X_i) be an i.i.d. sequence of ground-up losses, (Y_i) be the associated loss amounts in the "Beta" layer $D \le x \le D+L$ and $Z=\sum_{i=1}^{N} Y_i$ the corresponding aggregate loss. Similarly, let $(\tilde{X}_i)$, $\tilde{X}_i = X_i 1_{X_i>\delta}$, be the losses greater than the displacement δ and $\tilde{Z}=\sum_{i=1}^{\tilde{N}} \tilde{Y}_i$, $\tilde{N}=\sum_{i=1}^{N} 1_{X_i>\delta}$, the corresponding "Beta" aggregate loss amount. Some elementary considerations then show that $F_Z \equiv F_{\tilde{Z}}$ holds for the aggregate loss distributions, provided that $\delta < D$. ***The Peaks-Over-Thresholds Model (Pickands-Balkema-de Haan Theorem)*** on the other hand says that the ***exceedances of a high threshold*** $t < D$ are approximately $G_{\xi,t,\sigma}(x)$ distributed, where $G_{\xi,t,\sigma}(x)$ is the ***generalized Pareto distribution*** with ***shape*** ξ, ***location*** $t \equiv \mu$ and ***scale*** $\sigma > 0$. The threshold $t < D$ is chosen in such a way that in a neighbourhood of t the MLE-estimate of ξ (and therefore the "Beta" premium) remains reasonably stable (see Fig. 4 below). For more details, see the paper *Extreme Value Theory in the BETA Product* by Paul Embrechts and Alexander McNeil, ETH Zurich.

[4] The ***generalized Pareto distribution (GPD)*** is defined by

$$G_{\xi,\mu,\sigma}(x)=\begin{cases} 1-\left(1+\xi\frac{x-\mu}{\sigma}\right)^{-\frac{1}{\xi}} & \xi \neq 0 \\ 1-e^{-\frac{x-\mu}{\sigma}} & \xi = 0 \end{cases}$$

where $x \ge \mu$ for $\xi \ge 0$ and $\mu \le x \le \mu - \frac{\sigma}{\xi}$ for $\xi < 0$. Compare this with the ***ordinary Pareto distribution (PD)***:

$$F_{\theta,a}(x) = 1-\left(\frac{a}{x}\right)^{\theta}, \ x > a.$$

get the associated optimal parameters. The above outlined scenario techniques provide an indication of the parameter uncertainty inherent in the estimation process.

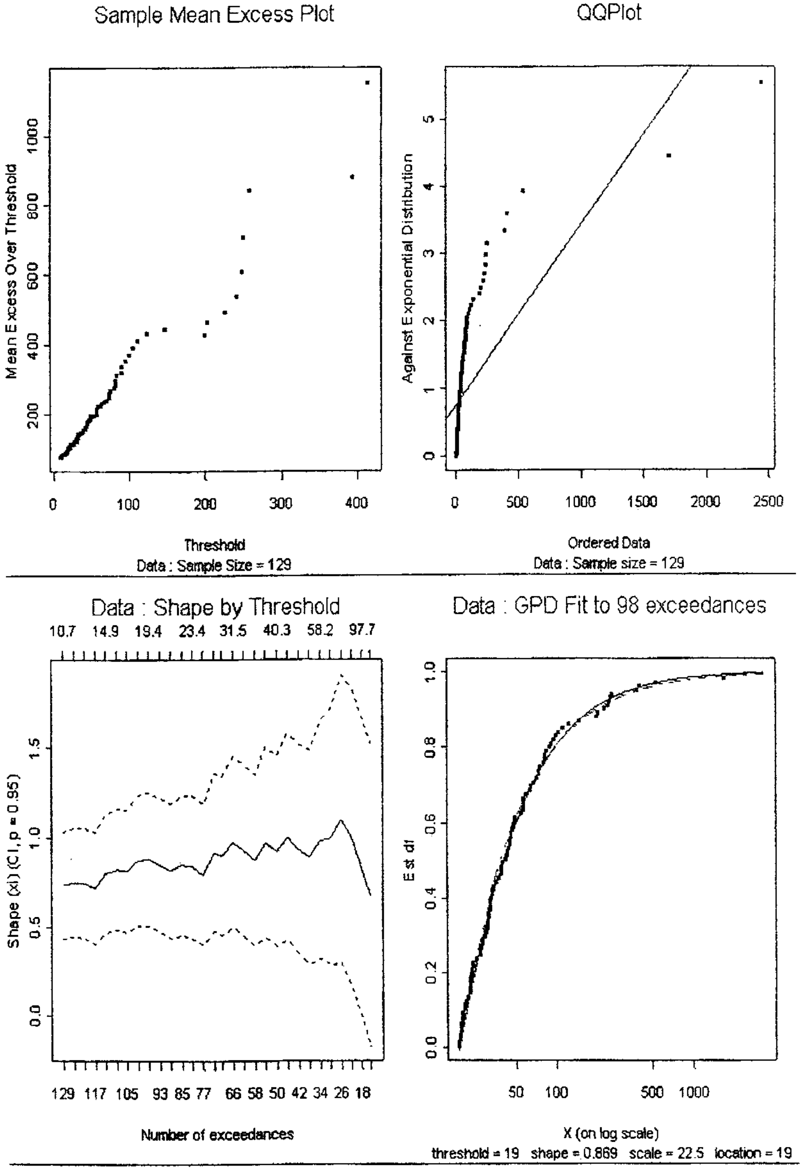


Fig. 4a: Oil & Petrochemicals Industry Severity Parameters (Property, Base Period)
Solid Line: GPD, Dotted Line: PD

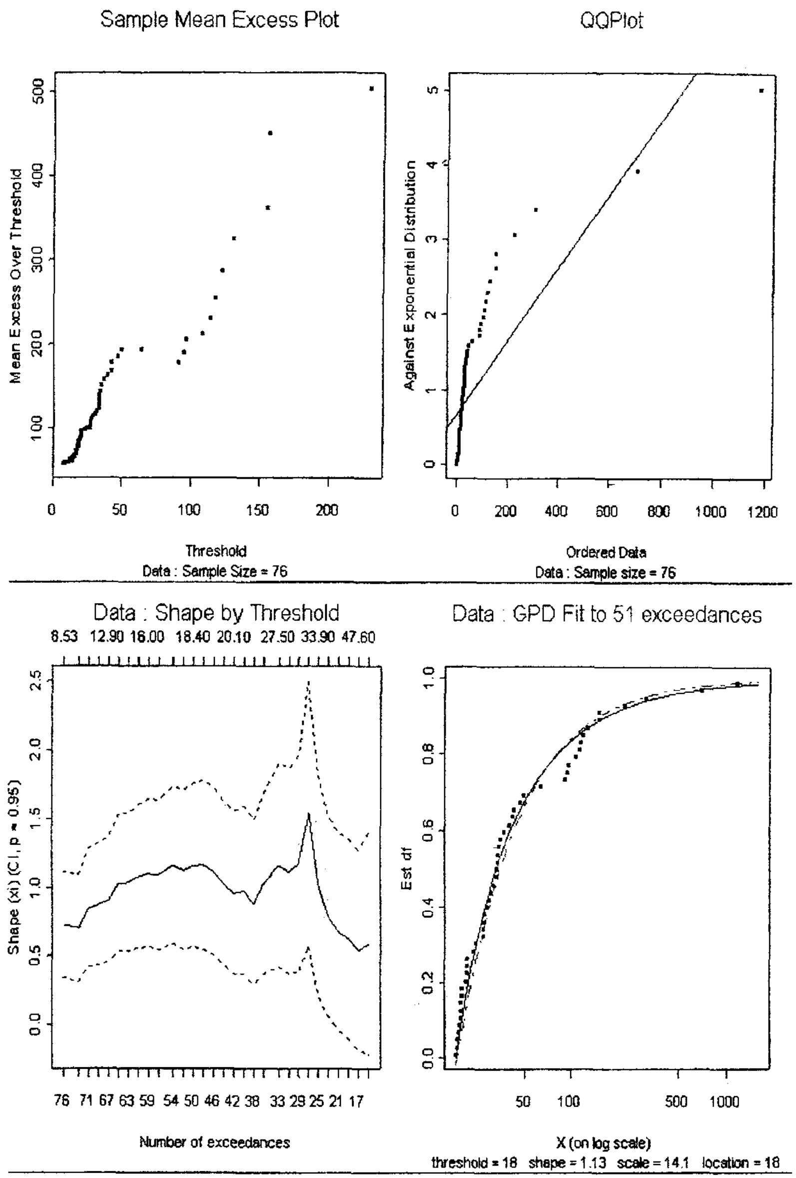


Fig. 4b: Oil & Petrochemicals Industry Severity Parameters (Casualty, Base Period)
Solid Line: GPD, Dotted Line: PD

(5) The ***frequency distribution model (excess of the data-specific threshold)*** is selected by estimating the mean and standard deviation from the annual frequency trends (see Fig. 2 above), with judgment modifications by the experienced Oil & Petrochemicals industry underwriter. Typically, the frequency distribution models utilized are either ***Poisson*** or ***negative-binomial*** (which allows recognition of significant changes in annual frequencies), whereby the parameters are estimated by MLE or by the method of moments. In developing the frequency models, relative changes in the exposure base (i.e., annual revenues or tangible assets) should also be recognized, where warranted.

Basic Scenario										
Property				mean	std		shape	scale	location
BP	Threshold	19.00	Frequency	4.90	3.45	Severity	0.8690	22.5000	19.0000
EAP	Threshold	21.00	Frequency	5.10	3.34	Severity	0.8710	25.0000	21.0000
Onshore									
BP	Threshold	15.00	Frequency	3.65	2.96	Severity	0.8430	25.7000	15.0000
EAP	Threshold	18.00	Frequency	3.65	2.96	Severity	0.8790	28.0000	18.0000
Offshore									
BP	Threshold	13.00	Frequency	2.00	1.30	Severity	0.5280	22.0000	13.0000
EAP	Threshold	15.00	Frequency	2.00	1.30	Severity	0.5250	25.5000	15.0000
Casualty									
BP	Threshold	18.00	Frequency	3.40	3.68	Severity	1.1300	14.1000	18.0000
EAP	Threshold	24.00	Frequency	3.40	3.68	Severity	1.1300	18.6000	24.0000
Adjustment Scenario									
Property				mean	std		shape	scale	location
BP	Threshold	32.00	Frequency	5.90	3.65	Severity	0.7830	44.5000	32.0000
EAP	Threshold	40.00	Frequency	6.10	3.70	Severity	0.7650	59.3000	40.0000
Onshore									
BP	Threshold	30.00	Frequency	3.80	2.78	Severity	0.7990	53.6000	30.0000
EAP	Threshold	40.00	Frequency	3.80	2.78	Severity	0.8010	71.1000	40.0000
Offshore									
BP	Threshold	33.00	Frequency	2.20	1.54	Severity	0.6890	31.7000	33.0000
EAP	Threshold	44.00	Frequency	2.20	1.54	Severity	0.6930	41.9000	44.0000
Casualty									
BP	Threshold	44.00	Frequency	3.47	3.60	Severity	1.2500	28.1000	44.0000
EAP	Threshold	70.00	Frequency	3.53	3.68	Severity	1.0300	64.1000	70.0000

Fig. 5: Oil & Petrochemicals Industry Parameters (Property and Casualty, Base Period: BP and Extended Agreement Period: EAP, all Scenarios[5])

(6) With the mathematical models describing loss severity and loss frequency distributions (see Fig. 5 above), ***annual aggregate loss calculations*** are performed, usually in constant dollar terms where ***the reference period is the middle of a "Beta" contract period (e.g., 1998/2001)***. Annual aggregate losses are described in terms of expected value and standard deviation (as well as higher moments where necessary). The calculations may be further extended to investigate annual aggregate loss potentials within high confidence levels (i.e., by considering the entire corresponding probabilistic loss distribution). Generally, annual aggregate loss estimates have more meaning at higher percentiles (e.g., the 90th, 95th

[5] To make this presentation simple, we only consider the ***basic scenario*** and an ***adjustment scenario*** (see p. 16 - 18 for more details on the general classes of "Beta" threat scenarios identified).

and 99th) since these percentiles reflect the potential for adverse loss experience (over and beyond expected value).

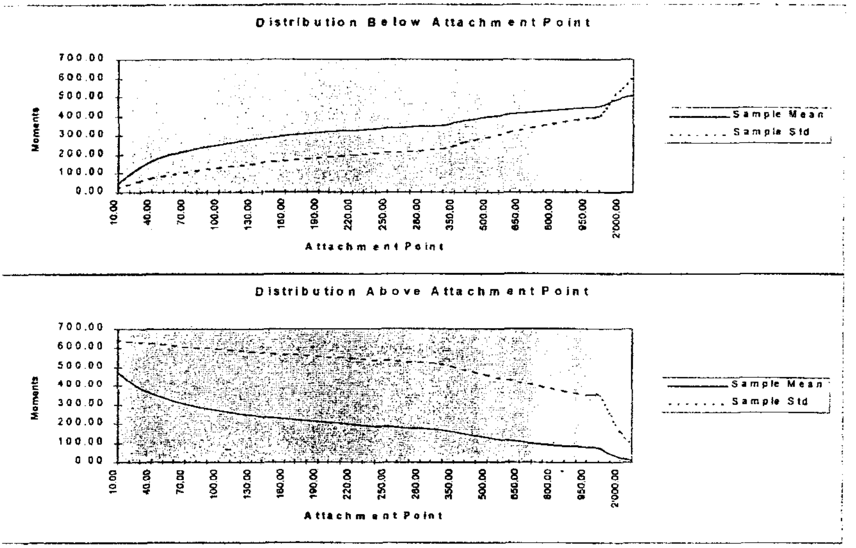


Fig. 6a: Oil & Petrochemicals Industry Annual Aggregate Losses (Property, Base Period)

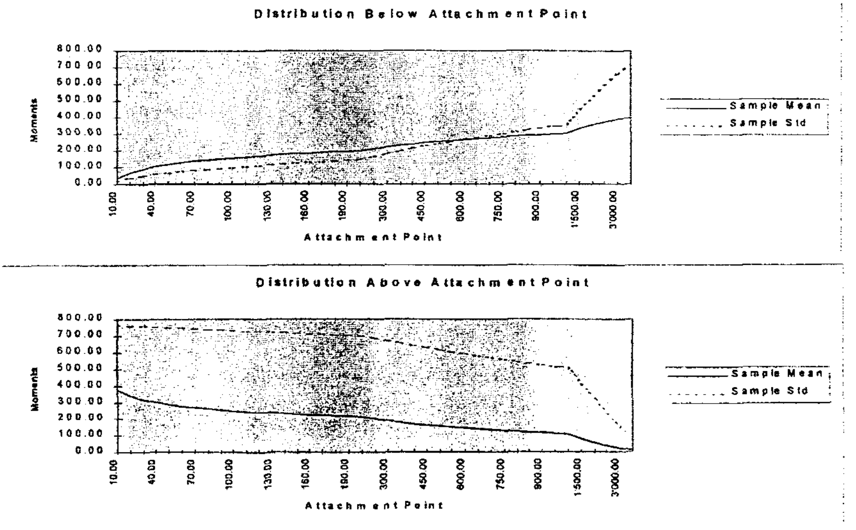
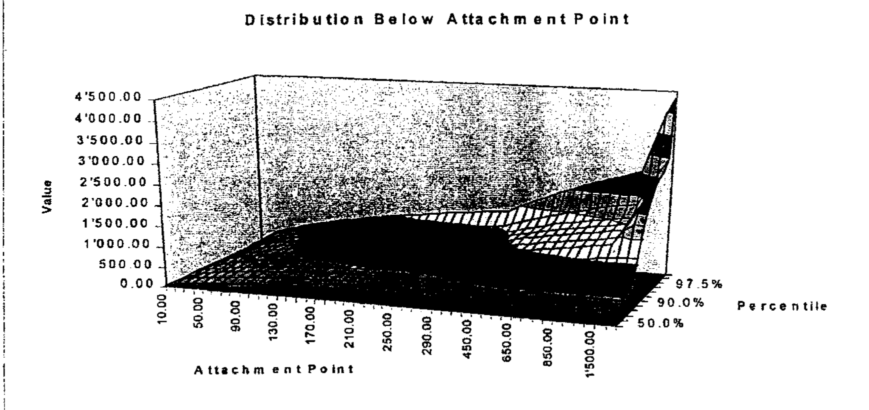


Fig. 6b: Oil & Petrochemicals Industry Annual Aggregate Losses (Casualty, Base

Period)

(7) Following the above annual aggregate loss calculations, per claim loss layers are selected and aggregate distributions both within the selected layers and excess of those layers up to the maximum potential individual loss (MPL) in the Oil & Petrochemicals industry (e.g., USD 3 billion for property and USD 4 billion for casualty) determined. This procedure is repeated for sequential layers (usually chosen at the discretion of the underwriter to approximate the anticipated "Beta" program structures reflecting the needs of the insureds or the entire industry), thus mapping out the "Beta" ***risk potential***. The resulting probabilistic loss profiles ("Beta" ***risk landscapes*** or ***risk maps***) can in a second step also be complemented by selecting appropriate aggregate loss limits in addition to the each and every loss limits and superimposing them on the potential losses within the chosen layers, thus further improving the flexibility of "Beta" program designs in the direction of combined single limits/deductibles.



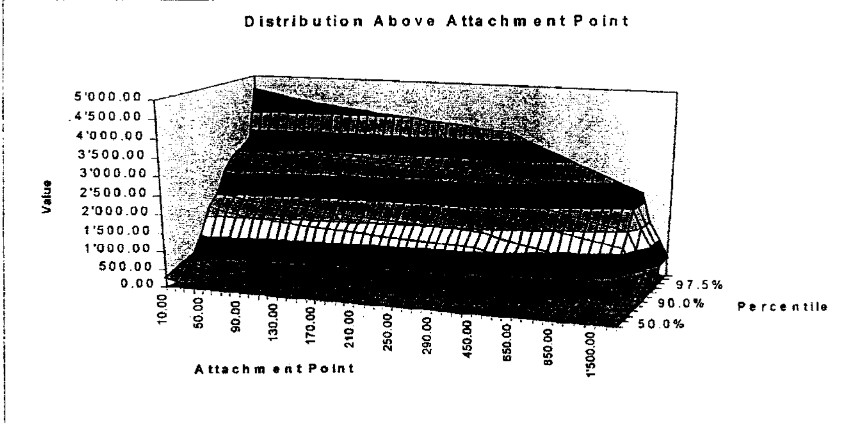
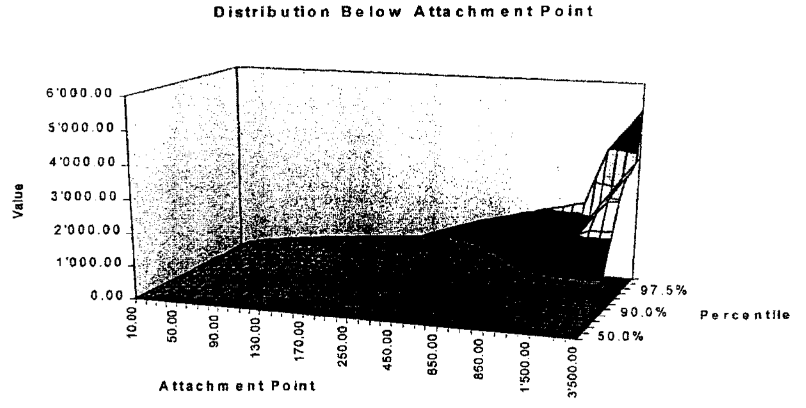


Fig. 7a: Oil & Petrochemicals Industry Risk Landscape (Property, Base Period)



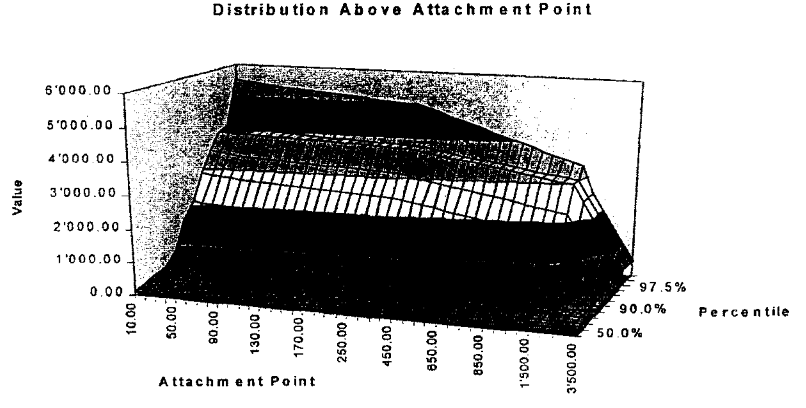


Fig. 7b: Oil & Petrochemicals Industry Risk Landscape (Casualty, Base Period)

(8) The same approach is finally also used to build probabilistic profiles of entire "Beta" (three year aggregate) ***loss portfolios***[6]. These optimal risk portfolios are structured in three dimensions: (a) across various exposures (e.g., property and casualty), (b) across time periods

[6] This is for the "Beta" ***standard layers*** USD 200M xs 300M property and USD 100M xs 200M liability. The parameters are taken from Fig. 5 and a ***normally distributed parameter uncertainty of 25% at the 95[th] percentile*** around these expectations is assumed for both frequency (Poisson) and severity (GPD). We also assume independent risks. The "Beta" implementation team has however looked into the issue of correlated risks and has developed corresponding models and pricing tools. Little can be done directly with existing historical loss information; ***scenario techniques*** have to be used instead. For an overview on the subject of correlated coverages and their rating, see the paper *Multiline Excess of Loss Rating* by Erwin Straub, Swiss Re Zurich.

(e.g., three years), (c) across insureds or groups of insureds (e.g., selected companies or industries).

	Basic Scenario		Adjustment Scenario	
	BP	EAP	BP	EAP
Sample Mean	182.96	224.50	418.41	656.91
Sample Std	168.27	184.96	252.18	308.83
%iles				
50.0%	175.30	200.00	400.00	626.11
66.7%	200.00	300.00	500.00	769.50
75.0%	300.00	313.32	582.27	849.76
80.0%	300.00	397.63	611.17	904.20
90.0%	400.00	500.00	760.46	1'071.08
95.0%	500.00	591.07	885.29	1'205.87
96.0%	507.73	600.00	904.56	1'249.56
97.0%	578.90	624.88	961.92	1'300.00
97.5%	600.00	665.49	995.49	1'333.30
98.0%	600.00	700.00	1'013.17	1'373.16
99.0%	700.00	778.39	1'110.58	1'487.60
99.9%	900.00	1'000.00	1'400.00	1'823.44

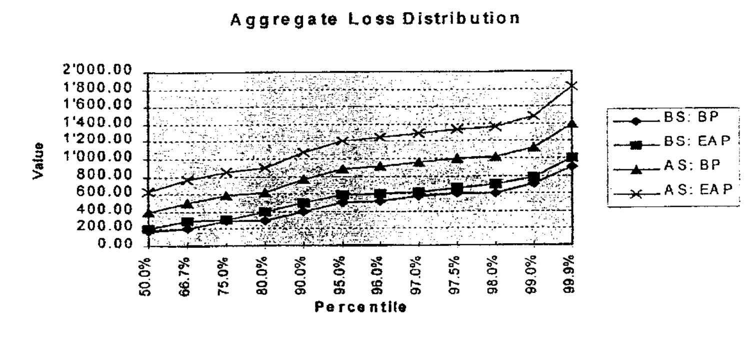


Fig. 8: Oil & Petrochemicals Industry "Beta" Loss Portfolio (3 Year Aggregate Loss Distribution, Property and Casualty, Base Period: BP and Extended Agreement Period: EAP, all Scenarios)

Based on the above probabilistic (annual aggregate) risk profiles for high-excess property and casualty Oil & Petrochemicals industry insurance coverage ("Beta" risk maps), different criteria can be used to select optimal layers for insurance programs that an experienced underwriter might desire to offer. Overall, optimal excess layers selected for "Beta" are characterized by low frequency. In particular, ***from Swiss Re's risk management point of view, optimal layers for "Beta" property and casualty excess coverages are defined as follows:***

No annual loss should pierce the chosen property or casualty excess layer more frequently than once every four years (based both on the historical and scenario annual aggregate

loss distributions). This translates into a 75% confidence that annual aggregate losses for a given layer of "Beta" coverage will equal zero.[7]

Monte Carlo Simulation Output - 1000000 Trials
Distribution Below Attachment Point

	50.00	100.00	150.00	200.00	250.00	300.00	350.00	400.00	450.00	500.00
Sample Mean	187.32	255.08	293.22	319.36	339.08	354.81	367.82	378.90	388.52	397.00
Sample Std	88.52	132.64	164.27	189.89	211.87	231.33	248.90	265.02	279.99	293.99
%iles										
50.0%	179.35	241.36	272.70	293.01	307.15	315.20	316.56	316.56	316.56	316.56
66.7%	219.86	300.78	347.62	379.11	403.22	423.77	440.78	453.73	461.23	462.62
75.0%	243.15	336.79	392.76	432.60	462.46	487.64	510.66	531.34	549.86	564.90
80.0%	259.73	362.39	425.21	470.99	506.02	534.56	560.68	585.19	608.42	629.97
90.0%	305.22	433.32	515.07	576.81	628.37	672.29	709.44	741.45	771.58	801.22
95.0%	345.07	494.98	594.47	671.46	735.82	792.25	843.80	890.74	932.61	968.65
96.0%	356.73	513.61	618.32	700.21	768.89	828.89	883.94	935.30	982.69	1'024.34
97.0%	371.37	536.38	648.30	736.03	810.48	875.13	934.51	990.22	1'042.60	1'091.09
97.5%	379.96	550.68	666.67	758.43	835.80	904.01	965.74	1'024.10	1'078.70	1'131.19
98.0%	391.09	567.50	688.19	784.61	866.82	939.49	1'004.06	1'063.94	1'121.83	1'177.56
99.0%	423.03	618.55	754.66	863.29	958.10	1'042.37	1'118.74	1'188.56	1'254.69	1'316.97
99.9%	516.76	771.16	952.94	1'101.03	1'235.57	1'350.73	1'462.37	1'565.15	1'663.86	1'760.41

Monte Carlo Simulation Output - 1000000 Trials
Distribution Above Attachment Point

	50.00	100.00	150.00	200.00	250.00	300.00	350.00	400.00	450.00	500.00
Sample Mean	335.99	268.23	230.09	203.95	184.23	168.50	155.49	144.41	134.78	126.30
Sample Std	619.65	596.11	573.94	554.79	537.08	520.44	504.68	489.64	475.20	461.28
%iles										
50.0%	114.47	37.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66.7%	233.71	137.38	72.84	19.01	0.00	0.00	0.00	0.00	0.00	0.00
[redacted]										
80.0%	435.72	324.29	246.96	183.56	126.65	73.47	22.43	0.00	0.00	0.00
90.0%	851.13	728.69	640.16	567.14	501.73	441.58	384.50	329.35	275.95	223.90
95.0%	1'543.79	1'416.69	1'324.26	1'245.44	1'175.59	1'110.98	1'048.58	989.96	932.69	877.22
96.0%	1'859.86	1'735.31	1'643.10	1'565.21	1'496.30	1'430.32	1'367.11	1'306.38	1'248.37	1'190.12
97.0%	2'360.71	2'235.44	2'143.00	2'061.86	1'990.18	1'923.32	1'859.13	1'798.99	1'741.24	1'682.69
97.5%	2'738.13	2'613.96	2'521.20	2'442.09	2'368.32	2'302.00	2'238.35	2'174.28	2'115.36	2'055.48
98.0%	2'950.00	2'900.00	2'850.00	2'800.00	2'750.00	2'700.00	2'650.00	2'600.00	2'550.00	2'500.00
99.0%	3'112.54	2'973.87	2'864.45	2'800.00	2'750.00	2'700.00	2'650.00	2'600.00	2'550.00	2'500.00
99.9%	4'416.39	4'243.44	4'096.63	3'969.85	3'842.47	3'729.47	3'616.93	3'510.64	3'404.12	3'296.89

Fig. 9a: Oil & Petrochemicals Industry Optimal Layer[8] (Property, Base Period)

[7] This optimality criterion is mainly derived from Swiss Re's perception (based upon an extensive Oil & Petrochemicals industry analysis) of a ***"Beta"*** or ***"catastrophic" event***. In the case of "Beta" programs with combined single limits/deductibles, lower percentiles and thus shorter contract maturities may be preferable from a marketing point of view.

[8] The ***minimum layer width*** can be determined as follows: Consider the ***80th percentile*** in the table containing the one year aggregate loss distributions ***below*** the attachment points 50M, 100M, 150M, .., etc. (keeping in mind that this percentile indicates the ***expected maximum loss in the fourth year***) and start with the "Beta" attachment point of 300M, i.e., an expected one year aggregate loss of about 535M. Moving to the upper "Beta" E.E.L. coverage point of 500M (= 300M "Beta" attachment point + 200M "Beta" limit), we have an expected annual aggregate loss of about 630M. ***This means that the expected one year aggregate loss in the envisaged***

Monte Carlo Simulation Output - 1000000 Trials
Distribution Below Attachment Point

	50.00	100.00	150.00	200.00	250.00	300.00	350.00	400.00	450.00	500.00
Sample Mean	119.35	158.04	181.38	198.41	211.93	223.20	232.88	241.40	249.00	255.89
Sample Std	68.69	101.49	126.72	148.24	167.43	184.98	201.26	216.53	230.97	244.72
%iles										
50.0%	112.50	144.07	162.40	167.65	167.65	167.65	167.65	167.65	167.65	167.65
66.7%	143.55	190.86	219.04	242.93	261.20	267.78	267.78	267.78	267.78	267.78
75.0%	162.06	219.43	254.24	283.03	309.61	333.30	350.00	356.71	356.71	356.71
80.0%	174.62	239.41	280.91	312.48	342.07	370.77	398.20	422.98	442.84	442.84
90.0%	211.78	295.84	354.48	402.01	439.91	474.51	508.82	542.89	577.58	612.32
95.0%	243.78	345.99	420.05	482.00	539.33	587.15	625.18	661.96	698.95	735.48
96.0%	252.90	360.93	440.27	505.52	566.47	621.89	666.05	704.89	742.26	779.82
97.0%	265.53	379.83	465.35	535.46	599.77	661.66	719.37	763.32	802.15	840.70
97.5%	272.48	391.55	480.31	553.90	620.67	685.14	746.89	800.00	843.61	883.39
98.0%	281.40	405.35	499.01	577.49	646.51	713.06	778.94	841.95	898.40	939.11
99.0%	308.19	447.69	554.08	646.43	728.68	802.30	874.09	944.73	1'015.69	1'084.74
99.9%	386.26	573.97	722.44	853.02	972.79	1'085.96	1'194.79	1'300.38	1'403.83	1'499.95

Monte Carlo Simulation Output - 1000000 Trials
Distribution Above Attachment Point

	50.00	100.00	150.00	200.00	250.00	300.00	350.00	400.00	450.00	500.00
Sample Mean	290.51	251.83	228.49	211.45	197.94	186.67	176.98	168.47	160.86	153.98
Sample Std	751.47	733.39	716.89	701.39	686.64	672.49	658.83	645.58	632.69	620.12
%iles										
50.0%	34.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66.7%	111.88	46.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75.0%	191.37	117.80	[illegible]	9.34	0.00	0.00	0.00	0.00	0.00	0.00
80.0%	271.99	193.74	133.28	79.11	27.65	0.00	0.00	0.00	0.00	0.00
90.0%	681.82	594.08	524.04	462.41	404.22	348.80	295.50	243.26	191.57	140.36
95.0%	1'542.57	1'450.22	1'374.72	1'307.51	1'244.40	1'184.24	1'127.45	1'072.70	1'018.00	963.29
96.0%	1'987.23	1'899.27	1'825.68	1'757.14	1'692.81	1'631.72	1'573.04	1'516.33	1'460.73	1'406.83
97.0%	2751.81	2660.33	2'584.25	2515.28	2451.94	2'390.74	2'330.24	2271.79	2214.61	2'159.40
97.5%	3'370.88	3'278.35	3'200.45	3'131.05	3'066.95	3'002.25	2'940.08	2'882.13	2'827.69	2'770.27
98.0%	3'950.00	3'900.00	3'850.00	3'800.00	3'750.00	3'700.00	3'650.00	3'600.00	3'550.00	3'500.00
99.0%	4'001.37	3'900.00	3'850.00	3'800.00	3'750.00	3'700.00	3'650.00	3'600.00	3'550.00	3'500.00
99.9%	5'372.86	5'234.51	5'110.91	4'989.90	4'879.60	4'774.73	4'669.34	4'563.09	4'456.05	4'351.46

Fig. 9b: Oil & Petrochemicals Industry Optimal Layer[9] (Casualty, Base Period)

"Beta" property layer is about 95M (= 630M - 535M) or, in other words, the "Beta" property coverage (without reinstatement) absorbes two such expected losses on an E.E.L. and a 3 Y AGG. basis. This was according to an extensive analysis (carried out during the "Beta" product engineering process) of the risk preferences in the Oil & Petrochemicals industry Fortune 500 segment considered to be sufficient for catastrophic events causing property damage. ***Similarly, on the casualty side, it transpired that a "Beta" layer width of 100M was considered sufficient; the expected one year aggregate loss in the envisaged "Beta" casualty layer (i.e., 100M xs 200M) being 59M (= 371M - 312M).***

[9] The determination of standard layers (i.e., ***optimal SIRs and limits***) for "Beta" alternative risk transfer solutions in the Oil & Petrochemicals industry (a similar approach is used in the other "Beta" target industries) is very important for the quantification of Swiss Re's Value Proposition for corporate clients in the Fortune 500 group of companies. The Value Proposition argument itself would be as follows: (1) Optimal layers for "Beta" coverages are characterized by ***efficiency and cost transparency***, a ***high degree of structural flexibility to optimally fit client's asset liability management (ALM) needs*** (see List and Zilch [1] and Davis and List [2]),

The following table characterizes the optimal three year excess layers (i.e., layers of property and casualty coverage where the probability of loss is low but where premium volume remains substantial) to be used by experienced Oil & Petrochemicals industry underwriters as a target range for "Beta" capacity:

Basic Scenario			Adjustment Scenario		
Property			*Property*		
BP	Opt. Attachment Point	300.00	BP	Opt. Attachment Point	600.00
EAP	Opt. Attachment Point	350.00	EAP	Opt. Attachment Point	800.00
Onshore			*Onshore*		
BP	Opt. Attachment Point	250.00	BP	Opt. Attachment Point	500.00
EAP	Opt. Attachment Point	290.00	EAP	Opt. Attachment Point	700.00
Offshore			*Offshore*		
BP	Opt. Attachment Point	90.00	BP	Opt. Attachment Point	180.00
EAP	Opt. Attachment Point	110.00	EAP	Opt. Attachment Point	240.00
Casualty			*Casualty*		
BP	Opt. Attachment Point	250.00	BP	Opt. Attachment Point	550.00
EAP	Opt. Attachment Point	300.00	EAP	Opt. Attachment Point	850.00

Fig. 10: Oil & Petrochemicals Industry Optimal Layers (Property and Casualty, Base Period: BP and Extended Agreement Period: EAP, all Scenarios)

4. Threat Scenarios

The "Beta" policy term is three years, with an option to extend the high-excess property and casualty coverage for another three years under the same conditions (assuming relative constancy of the underlying risk distribution and exposure base for a particular insured and industry). Oil & Petrochemicals industry "Beta" capacity is based on the notion of optimal layers of coverage which uses one year aggregate loss distributions for property and casualty claims. These parametric distributions can be estimated from corresponding loss information (i.e., Oil & Petrochemicals industry reference datasets) properly verified and adjusted by the experienced underwriter. In addition, in order to capture future risk dynamics, a sequence of standardized and adjusted loss scenarios should be developed for the initial three year "Beta" policy term (base period) from 1997 to 1999, in order to get a clearer picture of the sensitivity of the underlying layer optimization procedure to corresponding changes in risk exposure. Since the option to extend the "Beta" coverage is available at the inception of the initial three year contract term, additional scenarios for the extended agreement period from 2000 to 2002 should be developed by the experienced Oil & Petrochemicals industry underwriter in order to properly assess the impact of such a three year contract extension on "Beta"'s risk map (see Fig. 2 above). Five kinds of "Beta" ***threat scenarios*** following such a schedule are developed:

(1) ***adjustment scenarios*** showing the effects of an increase in the trending factor for both property and liability claims;

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significant capacity for property and casualty, long-term stability (Swiss Re capacity) and ***high financial security (AAA capital base)***. (2) "Beta" is a genuine alternative risk transfer product that may also include ***sophisticated financial markets components (balance sheet protection***, see Davis and List [2]) and a new element in the comprehensive range of Swiss Re's (re)insurance coverages and related services for Fortune 500 companies. Note that the "Beta" program also allows for property and casualty layers different from the standard layers (see below and also List and Zilch [1]).

(2) *frequency scenarios*[10] showing the effects of a higher claims frequency;
(3) *severity scenarios* showing the effects of a higher claims severity;
(4) *batch scenarios* showing the effects of claims series;
(5) *MPL scenarios* showing the effects of an extremely adverse maximum potential loss (MPL) estimate.

Bootstrapping[11] is the applied statistical/actuarial methodology. According to the experience of the "Beta" implementation team so far, under normal circumstances only an adjustment scenario (for property and casualty) has to be explicitly considered. The other scenarios just introduce additional parameter uncertainty into the original historical loss information and can therefore be replaced by a simulation approach to calculating aggregate loss distributions that allows for (e.g., normally distributed) parameter uncertainty. Recall that the "Beta" 3 year aggregate loss distribution for the Oil & Petrochemicals industry (see Fig. 8 above) was calculated with such a simulation approach under the assumption of at the 95th percentile 25% normally distributed[12] parameter uncertainty. Fig. 11 below shows the same aggregate loss distribution under the assumption of 0% parameter uncertainty:

	Basic Scenario		Adjustment Scenario	
	BP	EAP	BP	EAP
Sample Mean	201.00	244.72	443.43	678.85
Sample Std	172.67	189.52	255.86	311.63
%iles				
50.0%	200.00	200.00	406.85	650.79
66.7%	247.74	300.00	526.33	794.48
75.0%	300.00	359.67	600.00	875.43
80.0%	328.95	400.00	649.60	931.49
90.0%	428.96	500.00	793.67	1'096.37
95.0%	516.39	600.00	903.58	1'233.89
96.0%	556.32	620.29	943.50	1'277.85
97.0%	600.00	668.99	995.29	1'328.71
97.5%	600.00	699.94	1'014.39	1'362.25
98.0%	628.08	703.72	1'051.11	1'400.00
99.0%	700.00	800.00	1'151.11	1'514.38
99.9%	941.73	1'035.49	1'450.01	1'858.78

[10] Frequency scenarios play an important role when insureds require coverages below the optimal attachment point and also for examining the implications of "Beta" portfolio growth over time.

[11] For further details, see *An Introduction to the Bootstrap*, B. Efron and R. J. Tibshirani, Chapman & Hall 1993.

[12] For example, consider the shape parameter ξ of the property GPD in the basic scenario, base period (see Fig. 5 above): We assume then that $\xi \equiv \xi(\omega)$ is a normally distributed random variable with mean $m = 0.869$ such that

$$P(0.75m \le \xi \le 1.25m) \ge 0.95.$$

The same assumption is made for the frequency (Poisson) parameter λ and the other severity (GPD) parameters μ and σ.

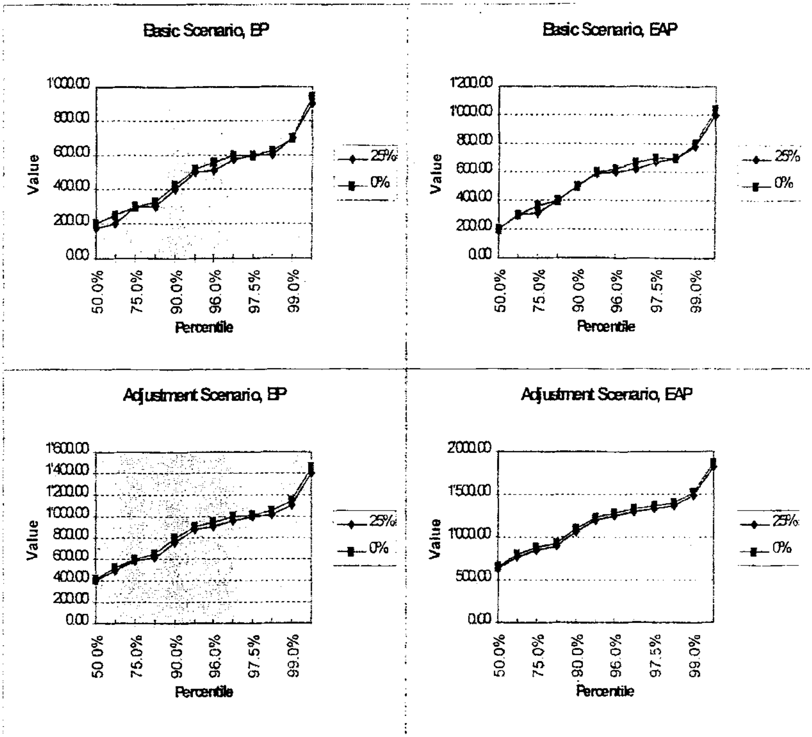


Fig. 11: Oil & Petrochemicals Industry "Beta" Loss Portfolio (3 Year Aggregate Loss Distribution, Property and Casualty, Base Period: BP and Extended Agreement Period: EAP, all Scenarios, 0% parameter uncertainty)

5. Value Proposition

Standard Risk Transfer Solution. The "Beta" ***standard coverage***

(I) USD 200M xs 300M (property)
USD 100M xs 200M (liability)

with ***current ("Beta" base period) premiums***[13]

[13] In these calculations, we can use the ***Value Proposition principle***

$$k_R^i = \frac{r_R RAC[X_R|i]}{\sigma[X_R|i]} \quad [\text{of course, in general: } k_R^i \sigma[X_R|i] \geq r_R RAC[X_R|i]]$$

$$k_R = \max\{..,k_R^i,..\}$$

Premium (3 Year Agg., Prop. & Liab., Ind.)$_0$ = 201,000,000 + k_R^0 * 172,670,000 USD

Premium (3 Year Agg., Prop. & Liab., Ind.)$_1$ = 443,430,000 + k_R^1 * 255,860,000 USD

and ***future ("Beta" extended agreement period) premiums***

Premium (3 Year Agg., Prop. & Liab., Ind.)$_0$ = 244,720,000 + k_R^0 * 189,520,000 USD

Premium (3 Year Agg., Prop. & Liab., Ind.)$_1$ = 678,850,000 + k_R^1 * 311,630,000 USD

implements Swiss Re's Value Proposition for Fortune 500 clients in the Oil & Petrochemicals industry: the associated "Beta" risk maps (see Fig. 9 above) indicate the ***optimal self-insured retentions***[14] ***(SIRs, = optimal "Beta" attachment points)*** for such companies. ***Typical parameters*** for a large "Beta" target client in the Oil & Petrochemicals industry are:

Basic Scenario									
Property				mean	std		shape	scale	location
BP	Threshold	6.00	Frequency	2.82	2.36	Severity	0.9216	5.9472	6.0000
EAP	Threshold	6.50	Frequency	2.91	2.39	Severity	0.8573	7.3577	6.5000
TPL Liability									
BP	Threshold	9.44	Frequency	1.00	0.71	Severity	1.6130	8.1382	9.4400
EAP	Threshold	12.60	Frequency	0.92	0.64	Severity	1.4900	14.9804	12.6000
Adjustment Scenario									
Property				mean	std		shape	scale	
BP	Threshold	10.00	Frequency	2.64	2.25	Severity	0.7745	11.6164	10.0000
EAP	Threshold	13.80	Frequency	2.64	2.25	Severity	0.8436	13.9572	13.8000
TPL Liability									
BP	Threshold	22.97	Frequency	0.92	0.64	Severity	1.3649	41.3515	22.9700
EAP	Threshold	39.69	Frequency	0.92	0.64	Severity	1.3649	71.4554	39.6900

Fig. 12: Parameters (Property and Casualty, Base Period: BP and Extended Agreement Period: EAP, all Scenarios) of a large "Beta" target client[15]

to determine the actuarial loading factors in a way consistent with Swiss Re's Value Proposition, see List and Zilch [1].

[14] Note that the "Beta" product engineering process defines the optimal SIRs and limits (standard layers) on the basis of target industry reference datasets, and not on the basis of individual loss data. Such an approach leads to a ***standardization of corresponding risk transfer solutions*** (this is highly desirable if ***futures*** and ***options*** on such risk transfer solutions are envisaged, see List and Zilch [1], or, more generally, a ***securitization*** of such "catastrophic" risk portfolios in the capital markets is considered, see Davis and List [2]) and ***a higher stability of their characteristics*** (i.e., attachment points, limits and price; this is highly desirable because it makes the traditional risk transfer more predictable from a client's perspective). Of course, the "Beta" program also allows for individual risk transfer solutions (that may be based on individual loss experience) different from the standard solutions.

[15] Again, the underlying "loss history" is just synthetically created for the purpose of this paper. The results (i.e., the above parameters) derived with our extreme value techniques are however quite realistic and to within 25% parameter uncertainty (at the 95th percentile) accurate. Note that very often there is no or only insufficient

The results of the corresponding ***annual aggregate loss calculations*** are then (again, as in Fig. 6 for the entire Oil & Petrochemicals industry, just the basic scenario is considered)

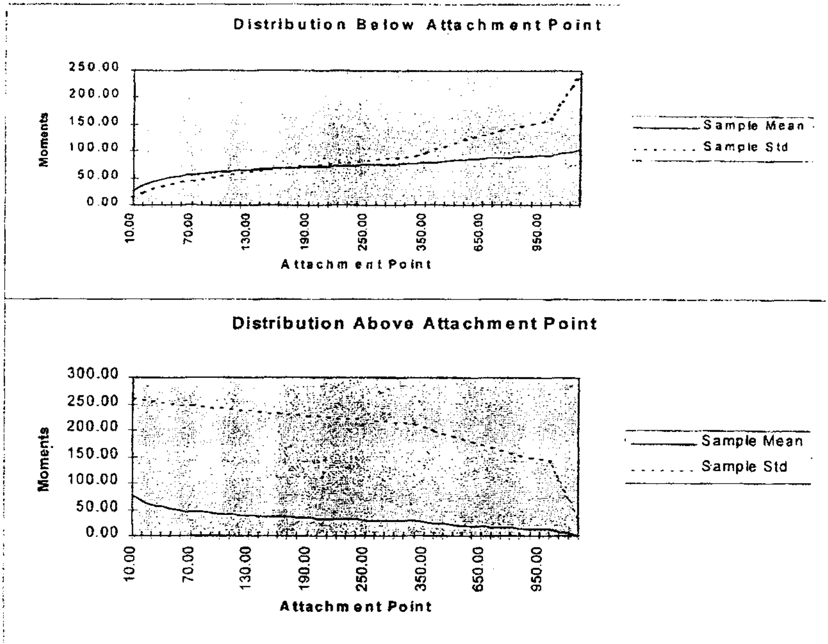
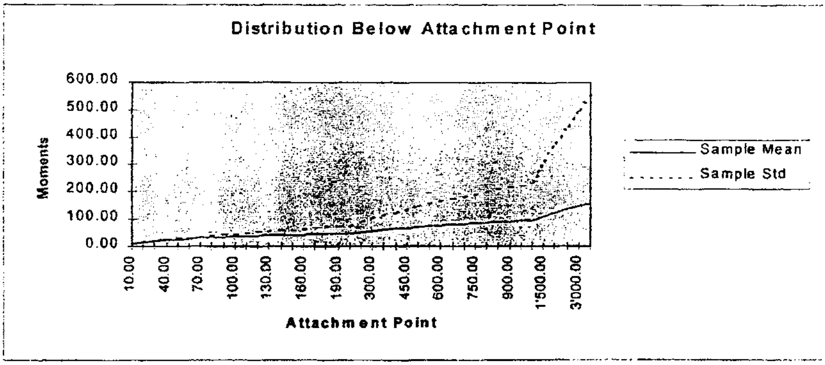


Fig. 13a: Annual Aggregate Losses (Property, Base Period) of a large "Beta" target client



historical loss information available on a single client basis. Therefore, exposure rating techniques have to be used quite often together with a ***benchmark approach that takes industry parameters for severity and "industry average" frequency as a priori estimates.***

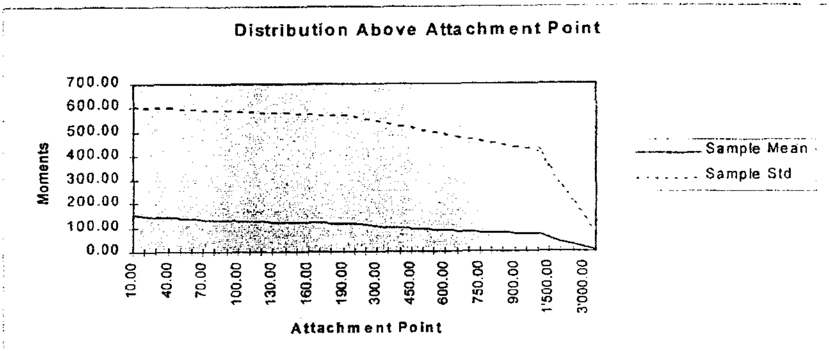
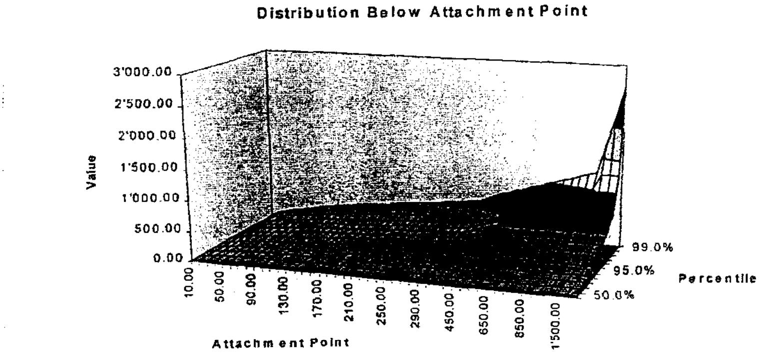


Fig. 13b: Annual Aggregate Losses (Casualty, Base Period) of a large "Beta" target client

the associated ***risk landscapes***



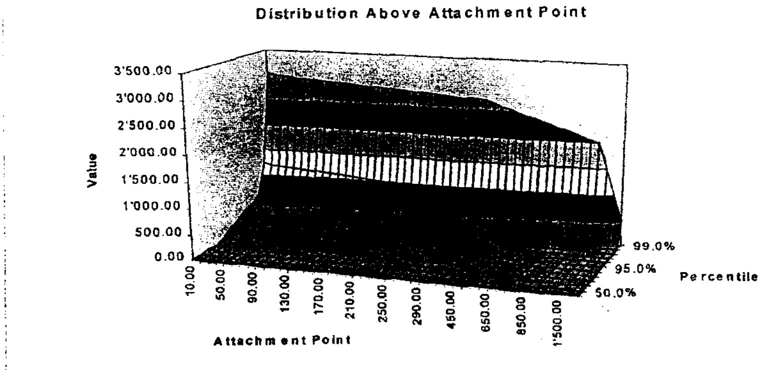
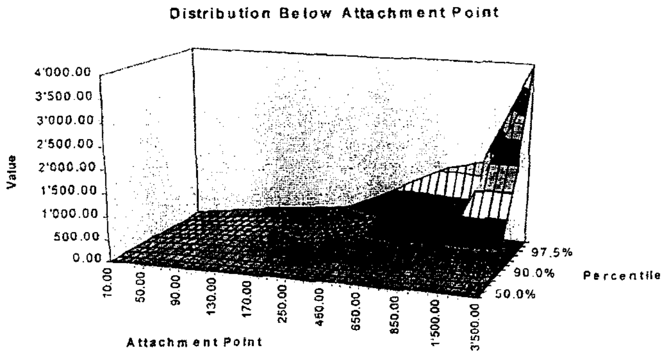


Fig. 14a: Risk Landscape (Property, Base Period) of a large "Beta" target client



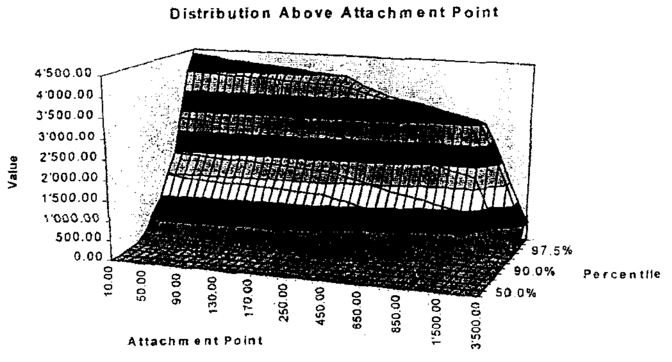


Fig. 14b: Risk Landscape (Casualty, Base Period) of a large "Beta" target client

and the *3 year aggregate loss distribution*[16] in the standard "Beta" layer (under the assumption of 0% parameter uncertainty)

[16] Note that on an Oil & Petrochemicals industry basis (see Fig. 11 above) as well as on a single client basis the chosen extreme value theory / simulation approach produces very stable percentile estimates - the effects of parameter uncertainty are insignificant. The 3 year aggregate loss distributions are the starting point for the calculation of the ***risk-adjusted capital (RAC)*** needed ***before*** and ***after*** a standard "Beta" risk transfer. Of course, the calculation of the risk-adjusted capital necessary to support "Beta" in the Oil & Petrochemicals industry is a very intricate process which has to take the risk landscape of the entire Swiss Re portfolio into consideration and cannot, therefore, be disclosed here. We found however that by using the pragmatic formula:

$\mathrm{RAC}\left[X_R\right]$ ***equals 2 times the 99th percentile of the "Beta" aggregate loss distribution (see Fig. 11 above)***

	Basic Scenario		Adjustment Scenario	
	BP	EAP	BP	EAP
Sample Mean	46.86	52.51	81.24	122.35
Sample Std	78.51	81.99	98.19	121.80
%iles				
50.0%	0.00	0.00	60.69	100.00
66.7%	28.85	78.86	100.00	158.57
75.0%	100.00	100.00	100.00	200.00
80.0%	100.00	100.00	159.79	200.00
90.0%	200.00	200.00	200.00	300.00
95.0%	200.00	200.00	300.00	361.57
96.0%	200.00	200.51	300.00	400.00
97.0%	221.87	261.01	300.00	400.00
97.5%	263.54	300.00	300.00	400.00
98.0%	300.00	300.00	336.06	426.33
99.0%	300.00	306.90	400.00	500.00
99.9%	469.48	500.00	550.91	691.99

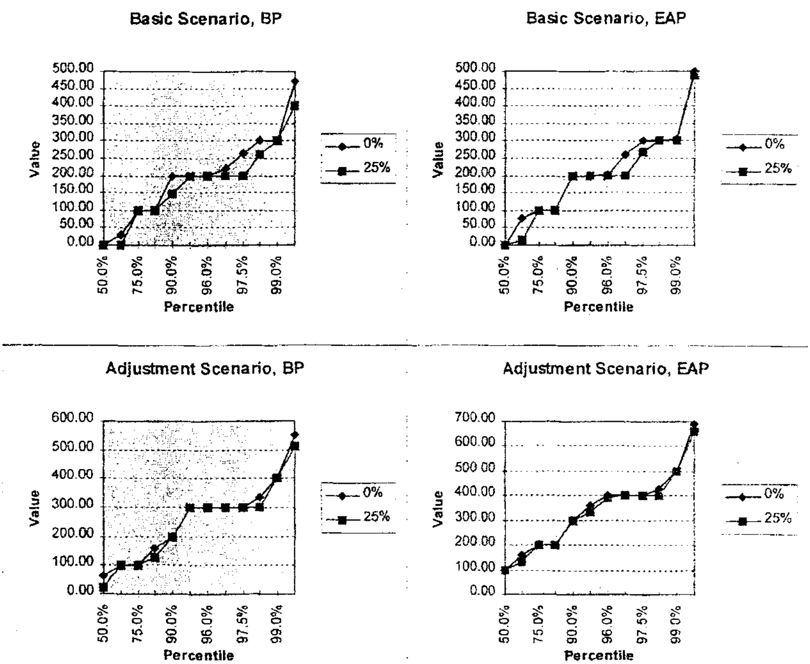


Fig. 15: "Beta" Loss Portfolio (3 Year Aggregate Loss Distribution, Property and

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minus USD 420M (corresponding premium estimate), we get a tolerable (conservative) approximation of the true value for $\mathrm{RAC}[X_R]$. For more details, see List and Zilch [1].

Casualty, Base Period: BP and Extended Agreement Period: EAP, all Scenarios) of a large "Beta" target client[17]

The ***quantification of Swiss Re's Value Proposition (VP) for the Oil & Petrochemicals "Beta" target industry*** (of 50 companies) is now in the following steps (see List and Zilch [1] for details on the underlying actuarial concepts):

(1) Determination of a Credibility Weight. Using the client's individual loss experience against the Oil & Petrochemicals industry average (benchmark), a detailed assessment of the underlying exposure suggests a credibility weight of $\alpha = 10\%$. This first step of the VP quantification already shows how traditional actuarial techniques (exposure assessment) and modern extreme value theory (stable estimation of the parameters of the individual / target industry loss experience) complement each other.

		Basic Scenario		Adjustment Scenario	
		BP	EAP	BP	EAP
Individual Client	Mean	46.86	52.51	81.24	122.35
(Fig. 15)	Std	78.51	81.99	98.19	121.80
Industry Average	Mean	4.02	4.89	8.87	13.58
(Fig. 11, 50 Companies)	Std	24.42	26.80	36.18	44.07
Credibility Parameters	Mean	8.30	9.65	16.11	24.46
(alpha=10%)	Std	29.83	32.32	42.38	51.84

Fig. 16a: "Beta" Credibility Parameters (3 Year Aggregate Loss Distribution, Property and Casualty, Base Period: BP and Extended Agreement Period: EAP, all Scenarios) for a large "Beta" target client[18]

[17] The same approach is taken for the calculation of the client's risk-adjusted capital $RAC[X_i]$ (before the "Beta" risk transfer, see Fig. 15 above). ***The 99th percentile corresponds to the client's risk aversion concerning "catastrophic" events being the same as Swiss Re's which basically means that the same quality (i.e., AAA) of risk-bearing capital is envisaged for the risk transfer.*** Securitization (see Davis and List [2]) would in principle make risk-bearing capital of a different (i.e., lesser) quality available for "Beta" risk transfer solutions; we do at this stage however not recommend such an approach as an in-depth analysis of the "Beta" implementation team has shown that for "catastrophic" exposures clients in the "Beta" target industries clearly prefer AAA-capital based risk transfer solutions.

[18] The same technique can also be applied if there is ***no individual loss experience*** (this is very often the case in practice). The industry average parameters then serve as a benchmark against which exposure information is used.

"Beta" Credibility

alpha (%)	MEAN	STD
0%	4'020'000	24'420'000
5%	6'162'000	27'124'500
10%	8'304'000	29'829'000
15%	10'446'000	32'533'500
20%	12'588'000	35'238'000
25%	14'730'000	37'942'500
30%	16'872'000	40'647'000
35%	19'014'000	43'351'500
40%	21'156'000	46'056'000
45%	23'298'000	48'760'500
50%	25'440'000	51'465'000
55%	27'582'000	54'169'500
60%	29'724'000	56'874'000
65%	31'866'000	59'578'500
70%	34'008'000	62'283'000
75%	36'150'000	64'987'500
80%	38'292'000	67'692'000
85%	40'434'000	70'396'500
90%	42'576'000	73'101'000
95%	44'718'000	75'805'500
100%	46'860'000	78'510'000

MEAN	STD	
46'860'000	78'510'000	Individual Client
4'020'000	24'420'000	Industry Average

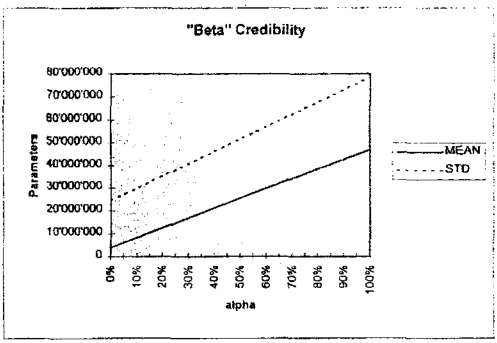

Fig. 16b: "Beta" Credibility (3 Year Aggregate Loss Distribution, Property and Casualty, Basic Scenario, Base Period) for a large "Beta" target client

(2) ***RAC/RORAC Allocation.*** Recall that ***RAC is allocated according to the (co)variance principle***, i.e., in the case of the basic scenario, base period, Swiss Re allocates

$$\text{USD } 29.25 \text{ M} = \left(\frac{29.83}{172.67}\right)^2 \cdot 980.00 \text{ M}$$

of risk-adjusted capital[19] to the large "Beta" Oil & Petrochemicals industry client under consideration. In general, the following Swiss Re RAC allocation is necessary:

	Basic Scenario		Adjustment Scenario	
	BP	EAP	BP	EAP
RAC Allocation (99th %ile)	29.25	34.32	51.64	72.20

Fig. 17: "Beta" RAC Allocation (3 Year Aggregate Loss Distribution, Property and Casualty, Base Period: BP and Extended Agreement Period: EAP, all Scenarios) for a large "Beta" target client[20]

During the "Beta" product engineering process it also transpired that corporate clients in the Oil & Petrochemicals industry accepted our RAC approximation (diversification just within the Oil & Petrochemicals industry "Beta" target portfolio) but would find it difficult to accept ***a rate of return on RAC (RORAC)*** of more than 8% (p.a.).

(3) Pricing (VP Principle) and Client RAC before Risk Transfer. As a final step, a management decision was taken to accept a RORAC minimum of $r_R = 6.5\%$ (p.a.) for the Oil & Petrochemicals industry "Beta" target portfolio and, using the ***Value Proposition pricing method*** which at a RORAC-equivalent $k_R = 1.6324$ (3Y) indicated a three year

[19] USD 980.00 M is the risk-adjusted capital for the Oil & Petrochemicals industry "Beta" target portfolio in the basic scenario, base period (see List and Zilch [1]). Note that ***RAC is allocated on a 3 year (= "Beta" contract maturity) basis here.***

[20] Swiss Re uses the ***99th percentile*** for the definition of RAC (Swiss Re is rated AAA).

"Beta" premium of USD 20'506'578, quote the "Beta" standard coverage at US D 6'835'526 p.a. (exclusive of the customary average expense load). In more detail, the premium and RAC figures are:

	Basic Scenario		Adjustment Scenario	
	BP	EAP	BP	EAP
VP Price	19.94	21.85	31.28	42.79
Client RAC (99th %ile)	580.06	591.95	768.72	957.21
Client RAC (95th %ile)	380.06	378.15	568.72	680.35
Client RAC (90th %ile)	380.06	378.15	368.72	557.21
Client RAC (80th %ile)	180.06	178.15	288.30	357.21
Client RAC (75th %ile)	180.06	178.15	168.72	357.21

Fig. 18: RAC Before Risk Transfer (3 Year Aggregate Loss Distribution, Property and Casualty, Base Period: BP and Extended Agreement Period: EAP, all Scenarios) for a large "Beta" target client[21]

(4) The VP Argument in Quantitative Terms. In quantitative terms, ***the primary customer value of a "Beta" risk transfer lies in the fact that for a corporate client a high percentage of otherwise needed risk-bearing capital is freed and can consequently be used to take advantage of investment opportunities that are related to the client's business (core competence)***[22]. Because of Swiss Re's AAA rating and very high risk management / client service standards there is no disadvantage to the client in such a transfer of "catastrophic" exposures to Swiss Re. As a percentage of the client RAC (before a standard "Beta" risk transfer), the ***risk-bearing capital freed because of a "Beta" standard risk transfer*** is:

	Basic Scenario		Adjustment Scenario	
	BP	EAP	BP	EAP
VP Effect (99th %ile)	94.96%	94.20%	93.28%	92.46%
VP Effect (95th %ile)	92.30%	90.93%	90.92%	89.39%
VP Effect (90th %ile)	92.30%	90.93%	85.99%	87.04%
VP Effect (80th %ile)	83.76%	80.74%	82.09%	79.79%
VP Effect (75th %ile)	83.76%	80.74%	69.39%	79.79%

Fig. 19: VP Effect of the "Beta" Risk Transfer (3 Year Aggregate Loss Distribution, Property and Casualty, Base Period: BP and Extended Agreement Period: EAP, all Scenarios) for a large "Beta" target client

Note here that securitization[23] (see Davis and List [2]) ***is an extension of the current Swiss Re Value Proposition (which is primarily centered around the idea of allocating risk-***

[21] In principle, the RAC calculations for a "Beta" target client can be ***based upon any percentile (reflecting the client's degree of "catastrophic" risk aversion)***. Choice of the 99th percentile is recommended because "Beta" risk transfers based upon AAA risk-bearing capital are clearly prefered by the majority of target clients in the Oil & Petrochemicals industry.

[22] If K is the capital freed, x is the rate of return (p.a.) of such investment opportunities and P the Swiss Re premium for the risk transfer, then, in monetary terms, ***the customer value generated by the "Beta" implementation of Swiss Re's Value Proposition*** is $3 \cdot x \cdot K - P$ (the factor 3 is used because of the capital and premium allocation according to "Beta" contract maturity).

[23] From an actuarial standpoint, securitization is a modern capital markets alternative for traditional retrocession agreements.

bearing capital in an efficient way) towards optimizing cashflow structures in addition to capital requirements.

Customized Risk Transfer Solutions. Of course, an insured's needs for high-excess coverages that are different from the above standard "Beta" coverage can easily be accomodated within Swiss Re's "Beta" program. For example, consider the ***customized coverage***:

(II)	Onshore Property	USD 100M po 550M xs 250M
	Offshore Property	USD 100M po 525M xs 250M
	General Liability	USD 100M xs 350M
	Aviation Liability	USD 100M xs 1350M
	Vessel Pollution	USD 100M xs 1050M

Then the ***Value Proposition argument*** is as follows (we consider only the basic scenario, base period; for the actuarial details, see again List and Zilch [1]):

(1) Credibility Parameters and RAC Allocation. Using the credibility weight of $\alpha = 10\%$, the credibility mean of the above coverage is 6.97 and the associated standard deviation 27.49 (see Fig. 20 below). RAC is again allocated with the (co)variance principle[24]:

$$\text{USD } 24.84 \text{ M} = \left(\frac{27.49}{172.67}\right)^2 \cdot 980.00 \text{ M}.$$

(2) Pricing (VP Principle) and Client RAC before Risk Transfer. Using the Value Proposition pricing method which at a RORAC-equivalent $k_R = 1.3706$ (3Y) indicates a three year "Beta" premium of USD 16'272'110, we quote the customized "Beta" coverage at USD 5'424'037 p.a. (exclusive of the customary average expense load). In more detail, the premium and RAC figures are:

	Basic Scenario		Adjustment Scenario	
	BP	EAP	BP	EAP
VP Price	15.59			
Client RAC (99th %ile)	492.66			
Client RAC (95th %ile)	322.79			
Client RAC (90th %ile)	322.79			
Client RAC (80th %ile)	152.93			
Client RAC (75th %ile)	152.93			

(4) The VP Argument in Quantitative Terms. As a percentage of the client RAC (before a customized "Beta" risk transfer), the ***risk-bearing capital freed because of a customized "Beta" risk transfer*** is:

[24] Note that the RAC calculations are only based on percentile estimates (the 99th percentile, usually) when the total RAC on a overall portfolio basis is to be determined. RAC calculations for sub-portfolios or single contracts are then via allocation with the (co)variance principle.

	Basic Scenario		Adjustment Scenario	
	BP	EAP	BP	EAP
VP Effect (99th %ile)	94.96%			
VP Effect (95th %ile)	92.30%			
VP Effect (90th %ile)	92.30%			
VP Effect (80th %ile)	83.76%			
VP Effect (75th %ile)	83.76%			

Recall also from List and Zilch [1] that there is a ***straightforward acceptability test for any new client and coverage***:

$$\frac{\sigma[X|i]^2}{E[X|i]} \le \frac{k_R}{r_R RAC[X_R|i]} \frac{\sigma[X_R|i]^3}{E[X_R|i]}$$

$$\left[\text{derived from: } k_R \sigma[X_R|i] \frac{E[X|i]}{E[X_R|i]} \ge r_R RAC[X_R|i] \frac{\sigma[X|i]^2}{\sigma[X_R|i]^2}\right].$$

"Beta" Credibility

alpha (%)	MEAN	STD
0%	4'212'279	22'755'846
5%	5'588'874	25'125'111
10%	6'965'470	27'494'377
15%	8'342'065	29'863'642
20%	9'718'660	32'232'908
25%	11'095'256	34'602'173
30%	12'471'851	36'971'439
35%	13'848'446	39'340'704
40%	15'225'042	41'709'970
45%	16'601'637	44'079'235
50%	17'978'233	46'448'501
55%	19'354'828	48'817'766
60%	20'731'423	51'187'031
65%	22'108'019	53'556'297
70%	23'484'614	55'925'562
75%	24'861'209	58'294'828
80%	26'237'805	60'664'093
85%	27'614'400	63'033'359
90%	28'990'995	65'402'624
95%	30'367'591	67'771'890
100%	31'744'186	70'141'155

MEAN	STD	
31'744'186	70'141'155	Individual Client
4'212'279	22'755'846	Industry Average

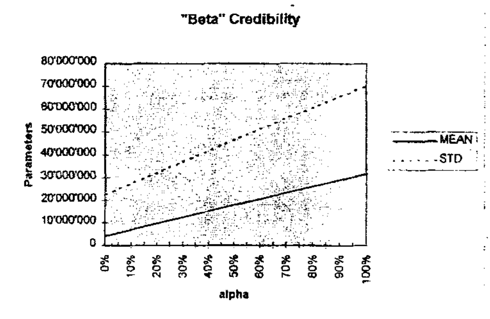

Fig. 20: "Beta" Credibility (3 Year Aggregate Loss Distribution, Customized Coverage, Basic Scenario, Base Period) for a large "Beta" target client

6. References

[1] H.-F. List and R. Zilch, *Extreme Value Techniques - Part I: Pricing High-Excess Property and Casualty Layers*, to appear in ASTIN 1998

[2] M. H. A. Davis and H.-F. List, *Risk/Arbitrage Strategies: A New Concept for Asset/Liability Management, Optimal Fund Design and Optimal Portfolio Selection in a Dynamic, Continuous-Time Framework - Part V: A Guide to Efficient Numerical Implementations*, to appear in AFIR 1998