

# **Institute of Actuaries of India**

## **Subject SA3 – General Insurance**

### **May 2012 Examination**

#### **INDICATIVE SOLUTION**

##### **Introduction**

The indicative solution has been written by the Examiners with the aim of helping candidates. The solutions given are only indicative. It is realized that there could be other points as valid answers and examiner have given credit for any alternative approach or interpretation which they consider to be reasonable

**Solution 1 :****a)**

The rating factors for large commercial Property Insurance insurance include:

Sum insured

- It is a measure of exposure

Occupancy

- It is a measure of risk potential as some industries are inherently more susceptible to fires than others. For example, paper manufacturing units are more vulnerable to damage from fires than iron manufacturing plants

Age of building

- It is a measure of structural vulnerability to fires, earthquake etc. Older buildings are more prone to structural damage in the event of a fire or earthquake

Construction type

- It is a measure of structural vulnerability to fire. Properties of superior construction type (reinforced concrete walls, ceilings and floors) are less vulnerable to damage in the event of a fire or cyclone as compared to Kutcha type construction

Fire protection facilities

- It is a measure of likelihood of damage in the event of a fire. For example, properties equipped with automatic sprinkler systems are less likely to be damaged in the event of a fire

Fire detection facilities

- It is a measure of the vulnerability of the property to fire.

Height of the building

- It is a measure of vulnerability to cyclones.

Risk inspection feedback

- It is a measure of the quality of the risk assessed by the risk inspection engineer.

Height above sea level

- It is a measure of vulnerability to floods (basement risks)

**b)** Experience rating represents rating based purely on the experience of the historic risk presented. The key advantages of experience rating are:

- The risks of anti-selection are reduced
- It allows for all material features of the risk presented

The disadvantages of experience rating are:

- Unless data can be presented in identical formats for all risks, a full actuarial experience analysis from scratch may be time consuming and considerable amount of expertise may be needed where more complex models are used
- Not all risks will have a sufficient volume of loss history to accommodate experience rating
- Large losses will result in the renewal premium being substantially higher

The key advantages of exposure rating are:

- It can be easily monitored, calibrated (if there is enough loss data) and managed
- It is simple and easy to use

The disadvantages of exposure rating are:

- It effectively places risks into groups and applies the same rate for each risk in that group. An insured's loss history and risk profile may not be adequately reflected in the calculated premium
- Without a large volume of relevant loss and exposure data, it can be difficult to assess an appropriate level for the various base rates and adjustment factors that are required
- It can lead to anti-selection if the rating system is poorly designed

c) The credibility weighted approach to rating involves assigning credibility weights denoted by  $Z$  to the experience rated premium and  $(1-Z)$  to the exposure rated premium. The credibility factor  $Z$  is determined firstly by assessing the minimum number of claims required to assign 100% credibility to the experience rated premium. This is arrived at based on the required probability that the expected value will lie within a pre-determined range of the actual value i.e. 90% probability that the expected estimate will lie within  $\pm 5\%$  of the actual value.  $Z$  is then calculated as  $Z = \min \{M/M_0, 1\}$  where  $M_0$  is the number of claims required for full credibility and  $M$  is the actual observed number of claims.

d) The expected gross flood loss equals  $25\% \times 250,000,000 = \text{INR } 62,500$ ,  
With a return period of 12 years, the annual cost equals INR 5.21 million.

Catastrophe XoL cost : [3 marks, ½ mark each entry]

	Gross loss	Net loss	Annual gross cost
Up to INR 10 million	10 million	10 million	0.83 million
10 million xs 10 million	2.2 million	0 million	0.183 million

The total annual Cat XoL cost equals INR 1.33 million. Of this 42.7% should be allocated to large commercial properties (5.21/12.2). Hence the total Cat XoL cost in respect of large commercial properties is INR 0.57 million

The reinsurance premium of INR 0.6 million is more than the annual cost of INR 0.183 million for the 10 million xs 10 million layer. Hence the proposed Cat XoL cover is unlikely to be good value for money.

[22]

## Solution 2 :

a) The premium and reserve risk parameters used for each line of business underwritten are:

	Premium risk parameter	Reserve risk parameter
Property Insurance	11%	10%
Engineering Insurance	7%	10%
Marine Insurance	12%	10%
Motor OD	9%	7%
Motor TP	12%	12%

- b) IRDA's Investment guidelines stipulate the asset categories in which an insurer might invest and the minimum/maximum percentage permitted.

Asset Category	Stipulations
Government securities	Includes central and state government securities. Insurer can invest not less than 20% up to a maximum of 85%
Government securities or other approved securities	Includes Government guaranteed bonds. Insurer can invest not less than 30% including government securities
Housing and Social Sector	Insurer can invest not less than 5%. Not more than 20% can be invested in a single company
Infrastructure	Insurer can invest not less than 10%. Not more than 20% can be invested in a single company
Approved Investment	Maximum of 55%. Not more than 10% can be invested in any one industry except in the case of banking and financial companies where 25% can be invested
Other investments	Not more than 25% of investment assets

- c) The fundamental principles to be followed for allocating capital by line of business are:

- The sum of the amounts of capital allocated to all the insurer's lines of business should be exactly equal to the insurer's total capital
- Any allocation method must consider the function the capital is performing. If the sum of the allocated amounts is less than the total capital, there is a residual amount not being used thereby understating the insurer's ability to write more business.
- The amount of capital allocated to any section of the insurer's book presenting an exposure to loss should be positive i.e. sections of the insurer's book giving rise to greater exposure to unfunded losses should be allocated greater amounts of capital under any rational allocation.
- The capital allocation should adjust in response to significant changes in the underlying risk.
- Capital allocation should be based to some extent on past results and must be relatively stable with respect to the insurer's results over the short term
- Any formulae used to make allocations should be explicit, objective and easily justifiable

- d) Allocation of capital in proportion to the net written premium

Advantages:

- Capital is allocated across lines of business in a simple and objective manner
- The proportion of capital allocated to each line of business will progress smoothly from year to year, if the premium income for that line of business grows at a similar rate

### Disadvantages

- Changing the premium rate levels for a line of business will impact the allocation of capital. In particular if the premium rates are decreased for the same cover, the probability of unfunded insurance losses arising increases, so that the capital necessary to fund these losses increases. However under this method of allocation, the amount of capital allocated to that line of business will be reduced
- Changes in the insurer's reinsurance programme will impact the net retention amounts and subsequently the amount of capital allocated.
- This method of allocation does not take into account the nature of underlying risks i.e. assuming the same quantum of net written premium, the amount of capital allocated to longer tailed Motor Third Party business would be the same as that allocated to the shorter tailed Motor Own Damage business.
- This method allocates no capital to a line of business which is no longer written. If this line of business takes a number of years to run-off and claims reserves still exist, then capital is required to protect against adverse run-off. The opposite problem would occur with a rapidly growing line to which large quantum of capital would be allocated.

### Allocation of capital in proportion to the accident year incurred claims

#### Advantages:

- Capital is allocated across lines of business in a simple explicit manner
- This method of allocation reflects increases or decreases in exposure

#### Disadvantages:

- This method of allocation fails to take account of the nature of underlying risks and hence the variability of expected claim amounts
- It makes no allowance for the adequacy of premium rates
- The method is subjective since it relies on the estimation of accident year incurred losses at the end of the accident year. This would be difficult to estimate accurately in the case of long tailed classes
- In the event of an under-estimation of accident year incurred losses, the outstanding claim reserves would be lower than required . Since one purpose of capital is to absorb deficiencies in claims reserves, the quantum of capital required in the event of an under-estimation should be greater. However under this method of allocation, the quantum of capital would be lower in the event of under-estimation of accident year incurred losses.

### Allocation of capital in proportion to the insurance profit by line of business

#### Advantages

- Capital is allocated across lines of business in a simple explicit manner

#### Disadvantages:

The use of a one-year allocation base is arbitrary. Profits of insurers are extremely volatile and hence this method of allocation will be unstable from year to year

- Where a given line of business produces underwriting losses, this method allocates

- negative capital amounts to that line of business. If a line of business is at the bottom of the underwriting cycle, its marginal profits will be low while at the same time its potential for unfunded losses will be high.
- This method takes into account growth patterns and run-off posed by one year methods. For example, a growing line of business presents an exposure to unfunded losses on new business which may be out of proportion to its reserves and other liabilities arising in earlier periods. Similarly short tailed lines presenting potential to catastrophic losses may be under represented in any allocation based on size of reserves.

[30]

**Solution 3 :****(a)**

1. Changes to settlement patterns but not to reporting pattern and case reserving adequacy
  - Paid CL is based on the assumption that there have been no significant changes to speed of settlement and payment
  - When this assumption is violated, paid CL method is not likely to produce reliable results while it should not have any impact on incurred CL method
2. Changes to case reserve adequacy but not to claims settlement and payment pattern
  - Incurred CL assumes that the adequacy of case reserves is not changing over time or at least is relatively stable other than the inflationary pressures
  - If there has been a change in the adequacy of case reserves over the experience period, then the fundamental assumption of incurred CL method does not hold and is not likely to produce reliable results. This change should not impact paid CL method
3. Changes to reporting lags affect both paid chain ladder and incurred chain ladder. The impact may be different

**(b)(i)**

Two Assumptions:

- Incurred CL method assumes no change to case reserve adequacy
- Paid CL method assumes no change to claim settlement rate

Diagnostics:

(i)

Accident Year (1)	Reported Claim Count as at 31/12/2011 (2)	Cumulative Reported Dev. Factor (3)	Claim Count Developed to Ultimate (4)=(2)x(3)
2005	6171	1.100	6788
2006	6809	1.102	7505
2007	7505	1.106	8297
2008	7505	1.111	8338
2009	7482	1.120	8379
2010	8149	1.137	9263
2011	7834	1.311	10268

## Closed Claim Counts / Projected Ultimate Claims count

Accident Year	Evaluation Age in Months						
	12	24	36	48	60	72	84
2005	47.4%	75.8%	81.3%	84.8%	86.0%	87.2%	88.0%
2006	45.9%	75.2%	81.5%	84.4%	85.8%	87.1%	
2007	47.0%	75.1%	81.4%	84.6%	85.8%		
2008	47.3%	76.1%	81.6%	84.5%			
2009	44.3%	75.8%	81.3%				
2010	44.1%	75.3%					
2011	45.5%						

Observation: The claims settlement pattern has been pretty stable

(ii)

Average Paid Claim Size = (Paid Loss / Closed Claim Count) * 1000							
Accident Year	Evaluation Age in Months						
	12	24	36	48	60	72	84
2005	348	505	551	573	582	593	599
2006	444	586	637	662	674	682	
2007	502	674	725	758	772		
2008	575	768	837	875			
2009	702	884	969				
2010	800	1038					
2011	856						

The average paid claim size is increasing by about 15% every year. This could be due to inflationary pressures

Average Incurred Claim Size = (Incurred Loss / Reported Claim Count) * 1000							
Accident Year	Evaluation Age in Months						
	12	24	36	48	60	72	84
2005	424	582	605	617	626	649	651
2006	495	665	694	711	746	747	
2007	564	768	799	846	857		
2008	664	887	966	973			
2009	712	1,089	1,108				
2010	961	1,246					
2011	1,097						

The average incurred claim size increased by more 15% from the third last diagonal to the second last diagonal.

Average Case Reserve = (Incurred Loss - Paid Loss) / (Reported Claim Count - Closed Claim Count) * 1000							
Accident Year	Evaluation Age in Months						
	12	24	36	48	60	72	84
2005	545	1,057	1,161	1,330	1,474	2,046	2,221
2006	570	1,129	1,292	1,454	2,078	2,305	
2007	667	1,321	1,569	2,252	2,412		

2008	807	1,655	2,344	2,487
2009	727	2,384	2,521	
2010	1,183	2,477		
2011	1,451			

The average case reserve increased by 40% to 60% from the third last diagonal to the second last diagonal

**b.(ii)**

Claims Department:

- Have there been any changes to the data entry or the speed of claims processing?
- Have there been any significant changes in the guidelines for setting and reviewing unpaid case reserves during the last 7 years? Especially in the year 2010?
- Have there been any changes to claims settlement practices during the last 7 years?

UW Department:

- Any significant changes to company's book of business and mix of business over the last 7 years? Especially, the last two to three years?
- Any significant changes to the underwriting guidelines over the last 7 years? Especially, the last two to three years?

**b (iii)**

**Berquist Sherman technique to adjust incurred triangle for changes to case reserve adequacy**

- The average case reserve is triangle is adjusted in such a way that the average case reserve increases by 15% over a diagonal
- This is because the average paid amounts consistently increase by 15% from one diagonal to the next

**Adjusted Average Case Reserve Triangle**

Adjusted Avg Case Reserve = (Case Reserve) / (1.15^(2011 - CalendarYear) )							
Accident Year	Evaluation Age in Months						
	12	24	36	48	60	72	84
2005	627	1,232	1,441	1,635	1,824	2,004	2,221
2006	722	1,416	1,658	1,880	2,097	2,305	
2007	830	1,629	1,906	2,162	2,412		
2008	954	1,873	2,192	2,487			
2009	1,097	2,154	2,521				
2010	1,262	2,477					
2011	1,451						

**Adjusted Incurred Triangle**

Adjusted Incurred = Paid + Adjusted Case Reserve * (Reported Claims - Closed Claims)							
Accident Year	Evaluation Age in Months						
	12	24	36	48	60	72	84
2005	2378	3,630	3,821	3,875	3,949	3,989	4,017
2006	3,212	4,666	4,858	4,975	5,067	5,083	
2007	3,906	5,915	6,131	6,276	6,430		
2008	4,590	6,711	7,100	7,305			



2009	5,509	7,791	8,293
2010	7,031	10,151	
2011	8,590		

**Adjusted Incurred Loss Development**

Accident Year	Evaluation Interval in Months						
	12-24	24-36	36-48	48-60	60-72	72-84	84+
2005	1.526	1.053	1.014	1.019	1.010	1.007	
2006	1.452	1.041	1.024	1.018	1.003		
2007	1.514	1.037	1.024	1.024			
2008	1.462	1.058	1.029				
2009	1.414	1.064					
2010	1.444						
2011							

Select (wtd Avg)	1.460	1.052	1.024	1.021	1.006	1.007	
Cumulative	1.670	1.144	1.088	1.063	1.041	1.034	1.027

**Selection of Ultimate Loss**

Accident Year	Earned Premium	BF IELR	Paid Losses	Incurred Losses	Cumulative LDFs		Est. Ultimate Losses			Selected Ultimate Loss
					Paid CL	Incurred CL	Paid CL	Incurred CL	BF Incurred	
2005	4,883	90.0%	3,575	4,017	1.170	1.027	4,183	4,125	4,133	4,125
2006	5,981	90.0%	4,456	5,083	1.193	1.034	5,318	5,257	5,261	5,257
2007	7,588	90.0%	5,499	6,430	1.229	1.041	6,759	6,691	6,697	6,691
2008	8,981	90.0%	6,171	7,305	1.270	1.063	7,836	7,762	7,781	7,762
2009	10,725	90.0%	6,604	8,293	1.378	1.088	9,098	9,022	9,073	9,022
2010	14,171	90.0%	7,238	10,151	1.612	1.144	11,667	11,617	11,760	11,760
2011	17,881	90.0%	4,001	8,590	3.522	1.670	14,092	14,348	15,048	15,048
Total	79,758		37,544	49,869			58,952	58,823		59,666

Overall IBNR is now 9797.

**b (iv)**

(d)Year	GWP	Written Rate Change	Earned Rate Change	On-level Factors
2008	10000	0%	0%	1.153
2009	12500	10%	5.56%	1.093
2010	17500	-5%	1.25%	1.079
2011	20000	10%	3.00%	1.048
2012	22000	0%	4.76%	1.000

For 2009, the earned rate change could be assumed to be half of written rate change, which is 5%

For years 2010 to 2012, the earned rate changes could be assumed to be equal to the average of written rate changes in that year and the preceding year weighted by the corresponding written premiums

## Selection of Ultimate Loss

Accident Year	Earned Premium	BF IELR	Paid Losses	Incurred Losses	Cumulative LDFs		Est. Ultimate Losses			Selected Ultimate Loss
					Paid CL	Incurred CL	Paid CL	Incurred CL	BF Incurred	
2005	4,883	90.0%	3,575	4,017	1.170	1.027	4,183	4,125	4,133	4,125
2006	5,981	90.0%	4,456	5,083	1.193	1.034	5,318	5,257	5,261	5,257
2007	7,588	90.0%	5,499	6,430	1.229	1.041	6,759	6,691	6,697	6,691
2008	8,981	90.0%	6,171	7,305	1.270	1.063	7,836	7,762	7,781	7,762
2009	10,725	90.0%	6,604	8,293	1.378	1.088	9,098	9,022	9,073	9,022
2010	14,171	90.0%	7,238	10,151	1.612	1.144	11,667	11,617	11,760	11,760
2011	17,881	90.0%	4,001	8,590	3.522	1.670	14,092	14,348	15,048	15,048
Total	79,758		37,544	49,869			58,952	58,823		59,666

Suggested 2012 Loss Ratio is 81.4%. It is the overall on-level incurred losses divided by the on-level used-up premiums

**Note:**

- The earned premiums for all the AYs are brought to 2012 rate levels using on-level factors
- The used-up earned premium is calculated for each AY (Earned Premium divided by Incurred CDF)
- The incurred claims are brought to 2012 levels to take into account the inflation of 2% per annum
- The sum of on-level incurred claims for all AYs divided by used-up premiums for all AYs gives the loss ratio at 2012 based on the past experience adjusted for 2012 rate level and claims cost level

**[30]****Solution 4 :****(a)**

They might be positively correlated:

- If current case reserves are stronger (or weaker) at the valuation date than assumed implicitly in the projected development pattern for one accident year, it is likely to be true for all accident years
- If claim processing has been disrupted in some way, that may very well affect all accident years
- If a judicial decision changes the likelihood of paying out on certain type of claims, that could affect all accident years

**(b)****(i)**

Year	LoB A		LoB B		LoB C		LoB D	
	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
2009	1000	129600	1500	360000	400	40000	1200	65400
2010	2500	360000	3000	810000	1000	78400	3000	181500
2011	4500	656100	5000	1000000	3500	313600	5000	330550
2012	7000	705600	7000	1254400	7000	490000	5500	355550

LoB	Carried Reserves for 2011 and Prior	Premiums for 2012
A	8000	7200
B	9500	7200
C	4900	7200
D	9200	5400

Aggregate of all years:

	Mean	Variance
LoB A	15000	1851300
LoB B	16500	3424400
LoB C	11900	922000
LoB D	14700	933000
All LOBs	58100	7130700

The aggregate loss distribution for all LoBs combined follows a normal distribution with mean 58100 and variance 7130700. The point corresponding to 99th percentile on this distribution is 64312.

Capital needed is this amount subtracted by the provisions =  $64312 - 58600 = 5712$ .

**(ii)**

Marginal capital for each LoB has to be calculated for the purpose of capital allocation.

To find the marginal capital for a given LoB, we need to find the capital for 1 in 100 probability of ruin without this LoB.

Marginal capital for this LoB would be the overall required capital minus the required capital without this LoB

	Liabilities without this LoB					Marginal Capital	Allocated Capital
	Mean of Liabilities	Variance of Liabilities	Assets Needed	Carried Reserves	Capital		
LoB A	43100	5279400	48445	43400	5045	667	1297
LoB B	41600	3706300	46079	41900	4179	1534	2983
LoB C	46200	6208700	51997	46500	5497	216	419
LoB D	43400	6197700	49191	44000	5191	521	1013

**(iii)**

The profit margin is about 2.8% ( $=200/7000$ ) for all LoBs except LoB D in 2012. However, the capital requirements for LoBs A, B and C are so different that using the same profit margin is not recommended

The profit margin is a negative 1.8% for LoB D indicating insufficient premiums in 2012.

**LoB A:**

Profit = 200 and Capital = 1297.

Healthy returns on capital. Expand more if feasible under the same profit potential or slightly lower.

**LoB B:**

Profit = 200 and Capital = 2983.

Not entirely satisfactory returns. Reduce the business in less profitable segments of this LoB

**LoB C:**

Profit = 200 and Capital = 419.

Extremely high returns. Expand the business in this LoB. This could be achieved by decreasing rates / increasing commissions etc

**LoB D:**

Profit = -100 and Capital = 1013.

Negative returns on capital. Reduce exposure in the most loss making segments of this LoB

**(c)**

- Necessary to obtain the distribution of losses net of reinsurance or simulated losses net of reinsurance.
  - For quota-share reinsurance, distribution of net losses would also follow a normal distribution with both mean and standard deviation of the gross loss distribution multiplied by the retention percentage
  - For excess of loss reinsurance, development of frequency-severity probability distributions within the context of a collective risk model is required
- It reduces the risk capital. In this example, the risk capital is based on Value at Risk. Reinsurance typically reduces the volatility of the losses and brings down the Value at Risk.
- It is likely to reduce the surplus as well. Ceded commissions, profit sharing, cost of reinsurance, other Reinsurance conditions, default risk etc also have to be considered
- Ratio of Surplus to risk capital could be used to evaluate the reinsurance options

[18]

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