SOCIETY OF ACTUARIES

NOVEMBER 2000

COURSE 5 EXAMINATION

SOLUTIONS

MORNING SESSION

APPLICATION OF BASIC ACTUARIAL PRINCIPLES

SECTION A—WRITTEN ANSWER

**** BEGINNING OF EXAMINATION 5 ****
MORNING SESSION

Answer to 1

a. Usually offered as companion coverage.
Optional amounts may be offered on an employee paid basis
Coverage may be non-occupational or 24 hour
Group AD&D coverage is typically a lump sum benefit, and a member who is eligible for Basic Group Term Life Insurance is eligible for AD&D also. Generally, no conversion is available at termination. Exclusions could be war, self-inflicted, illness or disease, infection (other than pyogenic at the time of injury), or during air travel as a pilot, student pilot, or air crew member. No income is imputed under Section 79 for this benefit (unlike basic group term life) as taxable income.

The benefit amount is typically equal to the Basic Group Term Life Insurance amount in the case of accidental death. Dismemberment benefit is typically 50% of the death benefit for loss of a single limb, and 100% of the death benefit of loss of multiple limbs.

Other benefit enhancements: seat belt use, child education.
Named beneficiary gets death benefit
The employee gets the dismemberment benefit
The loss must be within a specified period after the accident
Exclusion for suicide

b. Group Long Term Disability is typically triggered by the "own occ" definition – the member must be unable to perform the material & substantial duties of his own occupation. Typically, after 2 years the "any occ" definition must be met for continued payments, requiring the member to be unable to perform the material & substantial duties of any occupation for which they are suited by education or ability. Insured must suffer a 20% reduction in income. "Any occ" encourage disabled people to return to employment. A recent development is a definition of disability requiring that the member be unable to perform certain activities of daily living. This broader definition allows coverage of some risks that were previously ineligible (as a point of contrast, Social Security disability income benefits are subject to a requirement that the individual can't perform substantial gainful activity - $500 a month in a recent year). Typical exclusions are for war-related disability, self-inflicted disability, disability occurring in commission of a felony, a pre-existing condition excludes disability.

A waiting period, of typically either 3 months or 6 months, is applied before long-term disability benefits are payable. The waiting period equals the benefit period for short-term disability. Many insurers offer partial or residual benefits. May require total disability for awhile to qualify for partial/residual. Common to limit benefit for mental conditions to two years. The legality of this limit has been challenged.

Answer to 2

a. Buyer oriented strategies

- penetration pricing
  - set prices low enough to generate much higher level of sales
  - profit margin may be reduced, but overall profit may increase
  - can build economies of scale
  - best with commodity type products like term
  - commissions can be used as part of this strategy
- neutral pricing
  - price at level most buyers would consider reasonable
  - price/commission not far from industry coverage
  - very common in life insurance
- segmented pricing
  - different price for different buyers with different behaviors
  - examples: vary insurance price by age, gender, risk class, amount of insurance, market
- skim pricing
  - set price high to maximize profit margin
  - use where high demand and low supply
  - rare in life insurance

Competitor oriented strategies

- independent pricing
  - common where company has no real competitors
  - price set independent of prices of others
  - common in specialized niche markets, rare in large markets
- cooperative pricing
  - common where a few companies dominate market
  - pattern of stable prices, commissions, profits
  - most likely when high or costly barrier to entry
  - if profit margins too high, competitors may be attracted
- adaptive pricing
  - most common form of pricing behavior
  - review prices of others, then set own price
  - tendency to set price just higher than price leaders then try to compete on image, quality, service
  - often only strategy for companies that aren't strong competitors
- opportunistic pricing
  - use price as a competitive weapon
  - used by most efficient companies
  - drive prices down to level where only highly efficient can survive to force out others
  - used by large term writers
  - more companies using – rapidly changing prices and thinner margins

predatory pricing
- charging price below cost
- drive competitors out even at a loss
- raise prices when competition gone
- regulation generally prevents such pricing
- once raise prices, few barriers to competitors returning

b.

(i) 10-year level term

lapse rates
- important to sensitivity test lapse rate at end of level period (11^{th} year)

premium rates
- in general, to test profit sensitivity to change in premium
- in year 11, to determine profitability once select lives leave

mortality rates
- mortality deterioration highly likely at end of level premium period as healthy lives get re-underwritten for new insurance

mix of business
- average size mix
- risk class mix
- age mix

level of sales

(ii) universal life

lapse rates
- test various lapse levels once surrender charges expire
- ultra low lapses during surrender charge to test lapse support

premium payment
- test effect of higher premium termination rates
- test effect of higher/lower premiums versus target premium

interest rates
- perform scenario testing to explore way changing interest rates affect lapse rates, mortality, profits

mortality
- sensitivity of profits to different mortality levels

non-guaranteed policy charges
- test sensitivity of profits at different levels on on-guaranteed charges (e.g. current charges versus guaranteed maximum charges)

mix of business
- average size mix
- risk class mix
- age mix

level of sales

expenses – since UL may have much higher implementation costs than term, sensitivity test

b. inappropriate pricing assumptions
- using educated guesses for key assumptions
- not accounting for effect of new market, new distribution system or changes in economy
- not accounting for rational buyer and seller behavior
- offering product with commission and cash value greater than premium in first year
- offering product where profits depend on policyowners lapsing
- pricing a product where most cells subsidize a few high profile cells
- not clearly understanding cost of options granted to policyowner

not understanding your environment
- not accurately reflecting accounting, reserves, capital required, taxation
- pricing using terminal reserves and ignoring mean reserve conservatism
- not accurately reflecting timing of cashflows (e.g. taxes paid mid year not end of year)
- assuming tax advantages to policyowner never taken away (lapsation)

counting investment income on prior year profits in current year profits (should be excluded)

discounting using an inappropriate rate

discounting future losses with a high discount rate

Answer to 3

a. TUC $B_x = 0.01\,(S_{65})\,(x\text{-}e)$

(i) actual liability as of 1/1/2001 = $B_{45}\, v^{20}\, {}_{20}p_{45}\, a_{65}^{\cdot\cdot(12)}$

$$= \frac{0.01(50{,}000)(15)}{1.06^{20}} \quad (1)\ (10)$$

$$= 23{,}385.35$$

(ii) expected liability as of 1/1/2002 = $B_{46}^{expected}\, v^{19}\, {}_{19}p_{45}\, a_{65}^{\cdot\cdot(12)}$

$$= \frac{0.01(50{,}000)(16)}{1.0619}\,(1)(10)$$

$$= 26{,}441.04$$

(iii) actual liability as of 1/1/2002

$$= B_{46}^{expected}\, v^{19}\, {}_{19}p_{45}\, a_{65}^{\cdot\cdot(12)}$$

$$= \frac{0.01(52{,}500)16}{(1.06)^{19}}\,(1)(10)$$

$$= 27{,}763.09$$

(iv) liability loss as of 1/1/2001 = actual liability @ 1/1/2002 – expected liability @ 1/12002

$$= 27{,}763.09 - 26{,}441.04 = 1322.05$$

(a) PUC

(i) actual liability @ 1/1/2001 = $B_{45}\, v^{20}\, {}_{20}p_{45}\, a_{65}^{\cdot\cdot(12)}$

$$= \frac{0.01(50{,}000)(1.03^{20})(15)}{1.06^{20}}\ (1)(10)$$

$$= 41{,}006.36$$

(ii) expected liability @ 1/1/2002 = $B_{46}^{expected}\, v^{19}\, {}_{19}p_{45}\, \ddot{a}^{(12)}$

$$= \frac{0.01(50{,}000)(1.03^{20})(16)}{1.06^{19}}(1)(10)$$

$$= 46{,}364.53$$

(iii) actual liability @ 1/1/2002 = $B_{46}^{actual}\, v^{19}\, {}_{19}p_{46}\, \ddot{a}^{(12)}$

$$= \frac{0.01(52{,}500)(1.03)^{19}(16)}{1.06^{19}}(1)(10)$$

$$= 47{,}264.81$$

(iv) liability loss at 1/1/2002 = actual liability @ 1/1/2002 – expected liability @ 1/1/2002

$$= 47{,}264.81 - 46{,}364.53 = 900.28$$

(b) Both methods produce a liability loss but the loss under PUC is smaller than TUC. This is because:

- TUC does not project for any salary increases at all. Therefore when actual salary at age 46 ($52,500) turns out to be higher than what is expected at $50,000, this produces a loss (since benefit is a function of salary).
- PUC loss is smaller because a salary projection has already been included (3%). However, this 3% increase turns out to be smaller than actual salary (50,000 x 1.03 = 51,500 versus 52,500 (actual)

$\therefore$ A loss arises because of the insufficiency of salary increase originally assumed. If the salary increase had been at least 5% $\frac{52,500}{50,000} - 1$, PUC method will not produce a loss.

Answer to 4

(a) Reasons for deductibles include the following:

- small losses do not create a claim, thus saving the associated expenses
- for larger losses, the average claim payment is reduced by the amount of the deductible which results in premium savings
- the policyholder is at risk, which provides an economic incentive for him to prevent a claim
- the policyholder can optimize the use of limited premium dollars by using the deductible to save money where the value of the coverage is not as great

Problems associated with deductibles include the following:

- the insured may be disappointed that losses are not paid in full
- deductibles can lead to misunderstandings and bad public relations
- deductibles may make the marketing of coverage more difficult
- the insured may inflate the claim to recover the deductible
- may delay treatment, leading to higher claim cost

(b) Describe different types of deductibles commonly used today:

- fixed dollar deductibles – apply to each claim
- fixed percentage deductibles – percentage of either the loss or policy limit
- disappearing deductible – insurer pays nothing is less than $A; if loss exceeds $B, insurer pays full loss; if loss is between $A and $B, then linear proration occurs
- franchise deductible – is loss is less than $N, insurer pays nothing; if loss is equal to or exceeds $N, insurer pays full loss
- fixed dollar deductible per calendar year – used by health insurance or medical insurance policies; could vary between single and family coverage
- disability income and sickness insurance benefits often have elimination period, which is the period from the time of the disablement to the date that disability benefits begin

(c) Explain the reasons for placing a limit on policy coverage:

- it clarifies the insurer's obligation
- it provides an upper bound to the loss distribution for the insurer and lessens the risk assumed by the insurer
- it decreases the probability of insurer insolvency
- it decreases the premium that must be charged for the basic coverage
- it enforces the principle of indemnity, i.e. the insured should not profit from a loss
- it allows the policyholder to choose appropriate coverage at an appropriate price

Answer to 5

the participating policyholders are both the customers and owners of a life insurance company

the purchase of permanent life insurance is both a personal expenditure and a source of investment income. There is no completely satisfactory method to separate the taxable investment income and non-deductible expenditure in a manner that is simple, fair and understandable to policyholder and reasonable relative to other forms of investment

the long duration of permanent life insurance makes it difficult to determine annual income

permanent life insurance and annuity have been favorable treated by tax laws, and often to the detriment of the term and non-life forms of investment

the life insurance industry has not followed the general rules of income tax law and it always argues for exceptional treatment and has been successful

the statutory accounting is too conservative to use for income determination

political pressure has prevented taxing annually the investment income of permanent life insurance and the investment gains at death

government has made changes to the tax law to meet their revenue needs and not based on principles

stock life companies have argued and with considerable success, that the non-participating policyholders receive excess interest credits, experience refund, are significantly different from the participating policyholders receiving dividend, even though from economic and practical viewpoint, they are the same

millions depend on solvency life insurance companies

it maintains a balance between mutual and stock life insurance companies

beneficiaries of the advantages will not willingly part with those advantages in return for a more principled taxation of the result is higher taxes

Answer to 6

1. Rates should cover expected losses and expenses
2. Rates should make adequate provisions for contingencies
3. Rates should encourage loss control
4. Rates should satisfy regulators
5. Rates should be relatively stable

ABC's practice of setting low auto rates and high homeowner's rates violates Objective #1. The auto rates should be set independently and should cover expected losses and expenses associated with this line of business. There should be no subsidies between lines of business. If management decides to sell products below cost, they can, but the loss should come from the owner's equity or surplus, not another line of business.

ABC's former policy of lowering rates for good drivers was consistent with Objective #3 as it promoted loss control. This policy should be continued, if it is too expensive, maybe increase the number of years before the discount applies or reduce amount of discount.

Raising rates on property insurance by 50% violates Objective #2. Rates should have been set taking into account contingencies. An increase of 50% may not be acceptable to the regulators and will not be understood by the general public. Also, raising rates may cause a lot of policyholders to lapse. May want to consider reinsurance to stabilize rates. Unexpected event pricing should be included into the insurer's ratemaking practice each year.

Collecting data on a policy year basis means that any claim rising from a policy that was effective in calendar year Z will be accounted for as policy year Z. The exposure period is 24 months. The disadvantage of collecting data on a policy year basis is that it is not possible to obtain complete policy year information until after December 31, Z+1.

I recommend switching to accident year data as the data is quickly available and it is also a more common method.

The credibility formula is valid – it meets all requirements:

$$0 \le Z \le 1$$

$$\frac{dZ}{dE} > 0$$

$$\frac{d}{dE}\left[\frac{dZ}{dE}\right] < 0$$

However, using one formula for all lines of business is inappropriate

The choice of the formula will depend on the nature of the claims and severities, should look at each line of business severity and frequency of claims to determine appropriate formula. If severity has a small range then less claims are needed for full credibility.

Answer to 7

(i) Career Agents

- These are agents who sell for only one company
- One of the oldest forms of distribution
- May be trained by a general agent
- A general agent is given an allowance or reimbursement to set up an office and they receive an override commission on all sales
- a personal producing agent is a general agent on his own and therefore receives a larger commission
- agents also work through branches
- branch manager is an employee of the company
- this type tends to be on the decline

(ii) Worksite Marketing

- the sponsor is the employer
- may be payroll deduction
- must be actively at work
- employer considers benefit to employee
- employer endorses company

(iii) Direct Marketing

- no agent
- low response rate
- example: direct mail, internet, telemarketing, direct response (to an ad or commercial)
- usually little underwriting
- simpler products
- no commissions, but extra costs in advertising and marketing

(iv) Banks

- in some countries banks cannot sell life insurance
- in others, banks can market life insurance, but not sell it
- in others, banks can own life insurance companies and vice versa
- banks already have a distribution system and lots of customers, so it is very convenient
- usually sell term insurance to cover loans and mortgages or investment-type products
- usually simple products issues quickly with little or no underwriting

COURSE 5
MORNING SESSION

APPLICATION OF BASIC ACTUARIAL PRINCIPLES

SECTION B—SHORT WRITTEN ANSWER*

***These questions are worth 1 point each.**

SHORT WRITTEN-ANSWER QUESTIONS

Answer to 8

$$\text{coins \%} = \frac{\text{insured value}}{.75(\text{full value})} = \frac{75{,}000}{.75(125{,}000)} = .80$$

benefit = $damage * coins % - deductible

= 12,000 (.80) – 1000

= $8,600

SHORT WRITTEN-ANSWER QUESTIONS

Answer to 9

1. Missing tooth exclusion
2. Exclusion of cosmetic treatment
3. Time limit on major restoration like crown, bridges, dentures
4. Pre-authorization requirement if expected treatment more than certain amount
5. Limit TMJ payment
6. Alternative treatment clause
7. Pay/reimbursement based on usual and customary charges/ schedule fees
8. Computer adjudication
9. Scheduled plans

Answer to 10

- encourage new agents to service orphaned business
- discourage agents from replacing existing products because they can earn big 1st year commissions on new sales under heaped
- improve service on existing products since agents are paid more to service them; this increases product persistency

Answer to 11

- Annual payments will be easier and less expensive from an administrative standpoint (calculating the net amount at risk for each policy, etc.)
- The annual reinsurance payments will create a larger asset than the quarterly payments. The annual payment is made, but the reinsurer hasn't completely earned those premiums until the end of the year. Therefore, the annual payment will result in a larger reserve credit initially than the quarterly payments
- Cash flow advantage to paying premiums quarterly rather than annually
- The overall net amount at risk for each policy does not change substantially from one quarter to the next and calculating these amounts annually should be sufficient
- Less investment income for annual premium since premium paid up front
- Annual does not match dynamic products like UL or VUL as well as quarterly since NARs continually change

MORNING SESSION

APPLICATION OF BASIC ACTUARIAL PRINCIPLES

SECTION C—MULTIPLE CHOICE

Course 5
November 2000
Answer Key

1.	E	16.	A
2.	B	17.	D
3.	C	18.	B
4.	D	19.	E
5.	C	20.	B
6.	A	21.	C
7.	A	22.	E
8.	D	23.	D
9.	E	24.	C
10.	E	25.	A
11.	D	26.	A
12.	C	27.	B
13.	D	28.	A
14.	E	29.	B
15.	D	30.	B
		31.	A
		32.	B

**** BEGINNING OF EXAMINATION 5 ****
AFTERNOON SESSION
Beginning With Question 12

This afternoon session consists of 7 questions numbered 12 through 18 for a total of 40 points. The points for each question are indicated at the beginning of the question.

Answer to 12

a. Insurance is affected by the public interest. Public can be injured if companies do not adhere to standards.
Policies are long-term and the public must be able to trust the company to honor obligations.
Policies are complicated and technical, not understood by consumers, who are at a disadvantage.
Product and sales process are regulated to protect consumer rights and ensure companies are fair.

b. Uniformity – Replace 50 state system with one federal agency. This appeals to companies operating nationally.
Effective – Adequate federal budget and very qualified regulators. It is hard for small states with small budgets to be effective.

c. Flexible – state governments are more aware of local needs and can adapt better that a central bureaucracy.
Current U.S. system works, ongoing system has been doing the job. NAIC brings uniformity
Decentralized system appeals to smaller companies

Answer to 13

Must consider certain characteristic of the group as a whole (small group u/w)

1. Financial viability – how strong is the company
   - will they be able to make payments
   - will they be laying off people in the near future
2. Group size – as group size gets bigger, costs go down. Laws limit the amount of rating for group size.
3. Industry – affect the lifestyle of the workers
   - job stress, hazardous conditions affect claim levels
4. Workers' Compensation – often exclude claims covered by workers' compensation
   - require worker's comp before covering
5. Participation rate – require certain percent participation to reduce antiselection (some states require 75%)
6. Level of contributions – require employers to contribute certain amount in order to increase employee participation
7. Previous experience – why are they getting insurance now if it is their first time?
   - what is their past experience?
8. Eligibility rules/classes –
   - hourly vs. salary
   - part-time vs. full-time
   - who will be covered?
   - how is eligibility to be determined?

Must consider certain characteristics of each individual (U/W at the individual level)

1. Enforcement of eligibility – when there is a claim, make sure the person is eligible to receive benefits.
2. Pre-existing conditions – Protects insurer from anti-selection but HIPAA says can't put limits for people who have had coverage for the prior 12 months
3. Treatment of new and late entrants
   - distinguish since extra anti-selection from new/late
   - limits on pre-existing conditions
   - how many months before makes it pre-existing (12-18 months)
4. Past issue underwriting
   - make sure there is no fraud misstatement of age
   - if this is sound, return premiums and cancel coverage for that individual
5. Underwriting options
   - usually just make options available at issue
   - may require full participation in order to reduce anti-selection
6. Individual medical assessment
   - could be done for each individual to get rate for entire group, but can't reject individuals based on health status (HIPAA requires guaranteed issue)
   - can use short or long questionnaire with medical record or APS

Answer to 14

Hospitals
Discount off billed charges – pay percentage of billed charges (ex. 70% of billed charges)

Per diem – pay flat amount per day (i.e. 700 per day while in hospital). May differ from type of service (i.e. medical, surgical)

Case rate – flat fee for service (i.e. $5000 per hospital admit). Same amount no matter how long person in hospital. May pay case rate by DRG (different rate depending on DRG)

DRG – Medicare uses this system. Pay flat fee per Diagnosis Related Group (DRG). Subject to miscoding.

ASG – Hospital Outpatient Reimbursement System similar to DRG system. Outpatient procedure assigned Ambulatory Surgical code and get flat case rate for outpatient procedure

Global Capitation – fixed fee per member per month for hospital and physician services. Not very common. May age/sex rate the global capitation.

Capitation – set fee per member per month (ex. $30 per month for each enrollee). May age/sex rate the capitation

Percentage of premium capitation – pay a percentage of the gross premium to the hospital. Not very common.

Withhold arrangement – only pay certain amount of reimbursement to hospital and give them the rest as bonus if they meet certain utilization targets. Ethical issues with this form of reimbursement.

Physicians
Set fee schedule – negotiate a set fee schedule for physicians' services

Discount off billed charges – pay percentage of billed charges (ex. 70% of billed charges). Doesn't control utilization of services

Capitation – pay a set fee per member per month (ex. $20 per member per month). May age/sex rate the capitation based on age/sex factor

Global capitation – pay fixed fee per member per month for hospital & physician services

Withhold arrangement – only pay a certain amount of the reimbursement to the physicians and give them the rest as a bonus if they meet certain utilization targets. Ethical issues with this form of reimbursement.

Salary in staff model HMO's

Answer to 15

Expenses must cover the costs of:

- Product Development
- Distribution
- Underwriting
- Administration

Need to consider:

- Company Structure – organization of functions
- Expense policy – how is overhead allocated?
- Product related – what services are required for this product?
- Competition – what does the competition include in expenses?

Data can come from Internal Studies where expenses are recorded by function or from External sources such as LIMRA

Expenses can be allocated two different ways:

- Activity Based – expenses allocated by estimation of use
- Functional Expense – distribute by activity categories by line of business

Expenses can be expressed as a percent of premium, percent of claims or per policy

Answer to 16

a. Full Preliminary Term as reserve = 0, at the end of year 1, V1 = 0
V1 = PVFB1 – Net Premium Ratio x PVFP1 = 0
New Premium Ratio = PVFB1/PVFP1 = 46.80/47.77 = .9858
Initial Expense = NP Ratio x GP/unit – DB/unit x q1 / (1 + i) = .9858 x 6.50 – 1000 x .0045/ 1.05 = 2.0749

V2 = PVFB2 – Net Premium Ration x PVFP2 = 44.43 - .9858 x 43.23 = 1.810

b. Solvency Reserves

1. Ensure that insurance company meets its obligations to policyholders
2. Uses conservative assumptions
3. Ensures soundness of insurance company
4. Standards prescribed by regulators
5. Change in reserves is used in the calculation of distributed earnings
6. It impacts amount invested in the business
7. It impacts when return on capital realized
8. Limited ability to defer acquisition cost or acquisition costs expensed immediately
9. Results in new business strain

Earnings Reserve:

1. Purpose: to calculate earnings on a fair and consistent basis over time. Calculate earnings on a going concern or ongoing basis
2. Assumptions are less conservative than for solvency reserves or more realistic basis
3. Change in reserves used in calculation earnings reported to stockholders
4. Important for subsidiaries and local branches of foreign insurers
5. Defer most acquisition costs or amortize costs
6. Reduce or eliminate new business strain

Tax Reserves:

1. To calculate earnings used in tax calculations
2. Usually, Tax Reserves = Solvency Reserves
3. Advantages of Tax = Solvency
   - simple and easy to administer
   - promotes solvency
   - allows largest possible tax deduction
4. Some countries, Tax reserves < Solvency reserves, increases tax income

Answer to 17

a.

(i) Reflecting risk in profit goals

- there are many ways to reflect risk in pricing, but a realistic approach is recommended using best estimate assumptions with profit goals related to the degree of risk
- using conservative or padded assumptions produces results that are too difficult to interpret
- could reflect a degree of risk by developing a formula that determines the profit margin as a function of the degree of risk
- could set profit margin to reflect the estimated degree of risk – requires judgement
- examining product design and origin of assumptions could identify risks that require special treatment
- might be able to adjust product design to reduce risk
- might have to give consideration to unexpected occurrences – either through an explicit assumption or scenario testing

(ii) Discount rates and rates of return

- when pricing a product, need to determine what rate to discount income streams and to determine profit
- value for discount values affected by several factors
- company's cost of capital – weighted average and marginal
- company would not want to accept a rate of return less than the cost of capital
- what range of returns can be expected for alternate investments in other, similarly risky ventures (opportunity cost)
- company would not want to accept a rate of return less than what other ventures can provide unless good reason (strategically important or other ventures don't use all the funds)
- the company's current capital position and expected over next few years
- if lots o capital, might want to invest in short-term opportunities instead of leaving funds idle
- how will discounting be used?
- if discounting used to determine whether a product produces an acceptable rate of return, the discount rate should be based on the cost of capital or the opportunity cost
- discounting using after-tax interest rates uses the returns available on very safe investments (wouldn't be used as targeted rates of return – only for comparison to different stream amounts)
- discounting using before-tax interest rates has no theoretical basis
- basing the discount rate on the cost of capital or opportunity cost has greatest appeal but may be hard for mutual company to determine

(iii) Accounting basis

- many companies report one set of earnings to regulators based on solvency reserves and another set to stockholders based on earnings reserves
- when two sets are done, most favor using solvency reserves in pricing because they drive shareholders' investments in and returns from the business
- if heavy emphasis is placed on stockholders earnings, would probably price with them – would then use earnings reserves, solvency reserve and required capital
- some reject stockholder earnings as a basis because of added difficulty since almost every change requires a recalculation of earnings reserves

b.

(i) Embedded value

- equals present value of profits over n policy years, discounted at hurdle rate
- profits are after-tax solvency earnings or distributable earnings
- one of the simplest profit measures
- needs to define hurdle rate
- hurdle rate should be consistent with the return available on investments of comparable risks
- for a stock company, hurdle rate should be in line with the company's weighted average cost of capital
- can analyze embedded value generated by each product line
- negative embedded value happens when the rate of return of a product is less than the hurdle rate

(ii) Return on investment

- solve for discount rate that causes the present value of profits to equal zero
- profits are after-tax solvency earnings or distributable earnings
- calculations can blow up if all years are profitable or if the first year loss is small compared to the renewal years' profits
- can overcome this problem by calculating ROI in aggregate
- simpler ROI versus generalized ROI

(iii) Weighted average return on equity

- equals the present value of after-tax stockholder earnings divided by the present value of the equity base, over a period of n years
- equity base is beginning of year or average stockholder equity
- stockholder equity equals solvency reserves plus required capital plus DAC less GAAP reserves and deferred tax liability
- can weight policy year results by growth rates, ROI goals or hurdle rates

Answer to 18

(i) $NC = \dfrac{PVB - Assets - UAL}{\ddot{a}_{63:2\overline{|}}}$

PVB = present value of benefits

UAL = unfunded accrued liability (based initially on unit credit cost numbers)

$\ddot{a}_{63:2\overline{|}}$ = average future service

Projected benefit at retirement
= (12) (10) (33 yrs) = 3960

Accrued benefit at 1/1/01 = $= 3960 \text{ x } {}^{31}\!/_{33} = 3720$

Unit credit: AL = $(3720)(10)\left({}^{D_{65}}\!/_{D_{63}}\right) = (3720)(10)\left({}^{171}\!/_{215}\right) = 29{,}587$

***** I'm assuming they meant to give us D_{63} instead of D_{62}
If DOB = 1/1/38 he is 63 at 1/1/01. So I'm using D_{63} = 215 since initial assets are 0, UAL = 29.587 under traditional unit credit

$$PVP = (3960)(10)\left({}^{D_{65}}\!/_{D_{63}}\right) = 3960(10)\left({}^{171}\!/_{215}\right) = 31{,}496$$

again I'm assuming $N_{63} = N_{62}$

$$NC = \frac{31{,}496 - 0 - 29{,}587}{{}^{(N_{63} - N_{65})}\!/_{D_{63}}} = \frac{1909}{2287 - 1689} * 215 = 686$$

the UAL is amortized separately so the normal cost is 686 under this method

(ii) Frozen initial liability (entry age normal)
Need UAL based on EAN cost numbers

$$\frac{PVB_{EA}}{\ddot{a}_{32:3\overline{3|}}} = \frac{4613}{\frac{N_{32} - N_{65}}{D_{32}}} = \frac{4613}{\frac{23{,}018 - 1689}{1468}} = 317.50$$

Present value benefits at entry age

$$= (10)(12)(33)(10)\left({}^{D_{65}}\!/_{D_{32}}\right)$$

$$= (3960)(10)\left({}^{171}\!/_{1468}\right) = 4613$$

$$PVFNC = 317.50\left(\frac{N_{63} - N_{65}}{P_{63}}\right) = 317.50\left(\frac{2287 - 1689}{215}\right) = 883.0$$

PVB_{AA} = 31,496 (from last section
AL = 31,496 – 883 = 30,163

or $317.50\left(\frac{N_{32} - N_{63}}{P_{63}}\right) = 30{,}614$

UAL using EAN = 30,613
FIL – EAN

$$NC = \frac{31{,}496 - 0 - 30{,}613}{\frac{N_{63} - N_{65}}{D_{63}}} = \frac{883}{\left(\frac{2287 - 1689}{215}\right)}$$

NC = 317

(iii) Aggregate

$$NC = \frac{PVB_{AA} - Assets}{\frac{N_{63} - N_{65}}{D_{63}}} = \frac{31{,}496 - 0}{\left(\frac{2287 - 1689}{215}\right)}$$

= 11,324

(aggregate NC is so high because it doesn't set up a supplemental cost – you have to pay for this guy's benefit over the next 2 years)

***** Throughout this problem N_{62} and D_{62} for D_{63} and N_{63} was used

**** END OF EXAMINATION ****