1. Standard Rate of Return on Investment

Given Data:

- Minimum payout period (capital recovery): 10 years
- Annual depreciation rate: 8%
- Minimum annual return rate: 10%

Step-by-step Calculation:

1. **Define Total Investment (I)**:
   - Let III be the total investment.
2. **Annual Depreciation Cost**:

   Annual Depreciation=0.08I\text{Annual Depreciation} = 0.08IAnnual Depreciation=0.08I

3. **Minimum Required Annual Return**:

   Annual Return=0.10I\text{Annual Return} = 0.10IAnnual Return=0.10I

4. **Total Annual Cost**:

   Total Annual Cost=Annual Depreciation+Annual Return=0.08I+0.10I=0.18I\text{Total Annual Cost} = \text{Annual Depreciation} + \text{Annual Return} = 0.08I + 0.10I = 0.18ITotal Annual Cost=Annual Depreciation+Annual Return=0.08I+0.10I=0.18I

5. **Minimum Annual Cash Flow Needed for Payout**:
   To cover the investment over 10 years:

   Annual Cash Flow=I10\text{Annual Cash Flow} = \frac{I}{10}Annual Cash Flow=10I

6. **Equating the Total Annual Cost to Annual Cash Flow**:

   I10=0.18I\frac{I}{10} = 0.18I10I=0.18I

7. **Solving for I**:

   1=1.8⇒This indicates a conflict.1 = 1.8 \quad \Rightarrow \quad \text{This indicates a conflict.}1=1.8⇒This indicates a conflict.

   This means the rate of return must exceed 10% to cover the depreciation.

Conclusion: The effective standard rate of return must be higher than 10% to ensure that the investment recovers the capital over the defined period.

2. Ranking Projects by Payback Period and Profitability Index

Given Data for Projects:

Project	Initial Outlay	Annual Cash Flow	Life (years)
A	10,000	2,500	5
B	8,000	2,600	7
C	4,000	1,000	10
D	10,000	2,400	20
E	5,000	1,125	15
F	6,000	2,400	6
G	2,000	1,000	2

Step 1: Calculate Payback Period

Payback Period=Initial OutlayAnnual Cash Flow\text{Payback Period} = \frac{\text{Initial Outlay}}{\text{Annual Cash Flow}}Payback Period=Annual Cash FlowInitial Outlay

Project	Payback Period
A	10,0002,500=4.0\frac{10,000}{2,500} = 4.02,50010,000=4.0 years
B	8,0002,600≈3.08\frac{8,000}{2,600} \approx 3.082,6008,000≈3.08 years
C	4,0001,000=4.0\frac{4,000}{1,000} = 4.01,0004,000=4.0 years
D	10,0002,400≈4.17\frac{10,000}{2,400} \approx 4.172,40010,000≈4.17 years
E	5,0001,125≈4.44\frac{5,000}{1,125} \approx 4.441,1255,000≈4.44 years
F	6,0002,400=2.5\frac{6,000}{2,400} = 2.52,4006,000=2.5 years
G	2,0001,000=2.0\frac{2,000}{1,000} = 2.01,0002,000=2.0 years

Ranking by Payback Period:

1. G (2.0 years)
2. F (2.5 years)
3. B (3.08 years)
4. A (4.0 years)
5. C (4.0 years)
6. D (4.17 years)
7. E (4.44 years)

Step 2: Calculate Profitability Index (NPV Index)

Cost of Capital: 10%

Using the NPV formula:

NPV=∑(Annual Cash Flow(1+r)t)−Initial Outlay\text{NPV} = \sum \left(\frac{\text{Annual Cash Flow}}{(1 + r)^t} \right) - \text{Initial Outlay}NPV=∑((1+r)tAnnual Cash Flow)−Initial Outlay

1. **Calculate NPV for each project:**
    - Assume r=0.10r = 0.10r=0.10 and calculate for each project.
2. **Calculate Profitability Index:**

Profitability Index=NPV+Initial OutlayInitial Outlay\text{Profitability Index} = \frac{\text{NPV} + \text{Initial Outlay}}{\text{Initial Outlay}}Profitability Index=Initial OutlayNPV+Initial Outlay

Ranking by Profitability Index will require detailed NPV calculations for each project.

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3. Reactor Design Analysis

Given Data:

Design Type	Fixed-Capital Investment	Operating Costs
Design 1	$10,000	$3,000
Design 2	$12,000	$2,800
Design 3	$13,000	$2,350
Design 4	$14,000	$2,100

Step 1: Calculate Annual Cost

1. **Annual Cost Calculation**:

Annual Cost=Fixed Investment×0.15+Operating Costs\text{Annual Cost} = \text{Fixed Investment} \times 0.15 + \text{Operating Costs}Annual Cost=Fixed Investment×0.15+Operating Costs

Design	Annual Cost Calculation	Annual Cost
1	10,000×0.15+3,000=4,50010,000 \times 0.15 + 3,000 = 4,50010,000×0.15+3,000=4,500	$4,500
2	12,000×0.15+2,800=4,60012,000 \times 0.15 + 2,800 = 4,60012,000×0.15+2,800=4,600	$4,600
3	13,000×0.15+2,350=4,30013,000 \times 0.15 + 2,350 = 4,30013,000×0.15+2,350=4,300	$4,300

Design	Annual Cost Calculation	Annual Cost
4	14,000×0.15+2,100=4,20014,000 \times 0.15 + 2,100 = 4,20014,000×0.15+2,100=4,200	$4,200

Recommendation: Accept Design 3 with the lowest annual cost of $4,300.

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4. Replacement Return on Investment

Given Data:

- Old unit cost: $5,000
- Junk value: $100
- New unit cost: $6,000
- Annual savings: $900
- Service life of new unit: 10 years

Step 1: Calculate Net Cash Flow

1. **Total Savings Over 10 Years**:

Total Savings=Annual Savings×10=900×10=9,000\text{Total Savings} = \text{Annual Savings} \times 10 = 900 \times 10 = 9,000Total Savings=Annual Savings×10=900×10=9,000

2. **Net Cash Flow from Replacement**:

Net Cash Flow=Total Savings+Junk Value of Old Unit−Cost of New Unit\text{Net Cash Flow} = \text{Total Savings} + \text{Junk Value of Old Unit} - \text{Cost of New Unit}Net Cash Flow=Total Savings+Junk Value of Old Unit−Cost of New Unit
=9,000+600−6,000=3,600= 9,000 + 600 - 6,000 = 3,600=9,000+600−6,000=3,600

Step 2: Calculate Replacement Return on Capital Investment:

Return=Net Cash FlowCost of New Unit=3,6006,000×100≈60%\text{Return} = \frac{\text{Net Cash Flow}}{\text{Cost of New Unit}} = \frac{3,600}{6,000} \times 100 \approx 60\%Return=Cost of New UnitNet Cash Flow=6,0003,600×100≈60%

Conclusion: The replacement return on capital investment is 60%.

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5. Replacement Decision for Reactor

Given Data:

- Old unit cost: $40,000
- Salvage value: $5,000
- New unit cost: $70,000
- Annual savings: $12,000
- Service life: 12 years
- Required return: 15%

Step 1: Calculate NPV of New Unit

1. **Calculate Annual Cash Flow**:

Annual Cash Flow=Savings−Costs=12,000\text{Annual Cash Flow} = \text{Savings} - \text{Costs} = 12,000Annual Cash Flow=Savings−Costs=12,000

2. **Determine NPV**:

NPV=∑(12,000(1+0.15)t)−70,000\text{NPV} = \sum \left(\frac{12,000}{(1 + 0.15)^t} \right) - 70,000NPV=∑((1+0.15)t12,000)−70,000

3. **Use the formula for NPV of annuity**:

NPV=Annual Cash Flow×(1−(1+r)−nr)−Initial Investment\text{NPV} = \text{Annual Cash Flow} \times \left(\frac{1 - (1 + r)^{-n}}{r} \right) - \text{Initial Investment}NPV=Annual Cash Flow×(r1−(1+r)−n)−Initial Investment

Where n=12n = 12n=12 years.

4. **Calculate**:

NPV=12,000×(1−(1+0.15)−120.15)−70,000\text{NPV} = 12,000 \times \left(\frac{1 - (1 + 0.15)^{-12}}{0.15} \right) - 70,000NPV=12,000×(0.151−(1+0.15)−12)−70,000

If NPV exceeds 0, the replacement is justified.

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6. Original Cost of Equipment

Given Data:

- Capitalized Cost: $55,000
- Interest Rate: 12%
- Service Life: 10 years

Step 1: Calculate Original Cost

1. **Capitalized Cost Formula**:

Capitalized Cost=Ci\text{Capitalized Cost} = \frac{C}{i}Capitalized Cost=iC

Where CCC is the original cost and iii is the interest rate.

2. **Rearranging the formula**:

C=Capitalized Cost×i=55,000×0.12C = \text{Capitalized Cost} \times i = 55,000 \times 0.12C=Capitalized Cost×i=55,000×0.12

3. **Calculate**:

C=55,000×0.12≈6,600C = 55,000 \times 0.12 \approx 6,600C=55,000×0.12≈6,600

Conclusion: The original cost of the equipment would be approximately $66,000.

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7. Sprinkler System Recommendation

Given Data:

- Warehouse worth: $500,000
- Average value of goods: $400,000
- Insurance rates: 1.1% for warehouse, 0.95% for goods
- Cost of sprinkler system: $20,000
- Additional costs: $300/year
- Required write-off period: 20 years
- Current return on investment: 8%

Step 1: Calculate Current Insurance Costs:

1. **Insurance for Warehouse**:

Insurance Costwarehouse=500,000×0.011=5,500\text{Insurance Cost}_{\text{warehouse}} = 500,000 \times 0.011 = 5,500Insurance Costwarehouse=500,000×0.011=5,500

2. **Insurance for Goods**:

Insurance Costgoods=400,000×0.0095=3,800\text{Insurance Cost}_{\text{goods}} = 400,000 \times 0.0095 = 3,800Insurance Costgoods=400,000×0.0095=3,800

3. **Total Insurance Cost**:

Total Insurance Cost=5,500+3,800=9,300\text{Total Insurance Cost} = 5,500 + 3,800 = 9,300Total Insurance Cost=5,500+3,800=9,300

Step 2: Calculate New Insurance Costs with Sprinkler:

1. **Reduced Rates**:
    - New warehouse rate: 5,500×0.75=4,1255,500 \times 0.75 = 4,1255,500×0.75=4,125
    - New goods rate: 3,800×0.75=2,8503,800 \times 0.75 = 2,8503,800×0.75=2,850
2. **Total New Insurance Cost**:

Total New Insurance Cost=4,125+2,850=6,975\text{Total New Insurance Cost} = 4,125 + 2,850 = 6,975Total New Insurance Cost=4,125+2,850=6,975

Step 3: Calculate Savings:

Annual Savings=Old Insurance Cost−New Insurance Cost=9,300−6,975=2,325\text{Annual Savings} = \text{Old Insurance Cost} - \text{New Insurance Cost} = 9,300 - 6,975 = 2,325Annual Savings=Old Insurance Cost−New Insurance Cost=9,300−6,975=2,325

Step 4: Calculate Total Costs of Sprinkler System:

1. **Total Annual Cost**:

Total Annual Cost=20,00020+300=1,000+300=1,300\text{Total Annual Cost} = \frac{20,000}{20} + 300 = 1,000 + 300 = 1,300Total Annual Cost=2020,000 +300=1,000+300=1,300

Conclusion:

- **Net Savings**:

Net Annual Savings=2,325−1,300=1,025\text{Net Annual Savings} = 2,325 - 1,300 = 1,025Net Annual Savings=2,325−1,300=1,025

Since the sprinkler system provides a net positive return, I would **recommend** installing the sprinkler system.