Part 3 b

Basic Financial Evaluation and Benefits for improving, Safety and Efficiency

To obtain financial benefits to improve boiler efficiency we can use the following basic analysis.

1. **The Payback Period (PP)**
2. **The Present Worth Analysis (**PWA) (Including cost benefit ratio)

There are more methods for economic evaluation. However, it is preferable to use simple analysis at the beginning of the evaluation

1. The Payback Period (PP)

This analysis allows to estimate the period required to recover the investment

$$PP = FC / S$$

FC = First Cost (e.g. cost of labor and materials to implement scheme)

S = Net annual saving (e. g. annual fuel and safety savings less operating costs)

A payback period less than half the expected life is considered potentially profitable

The Return on Investment (ROI)

The Return on Investment **(ROI**) includes the depletion of the investment over lifetime by providing for a renewal through depreciation charge.

$$ROI = (S - DC) / FC$$

DC = Depreciation Charge (Annual depreciation of the investment)

FC = First Cost (e.g. cost of labor, safety, and materials to implement scheme)

S = Net annual saving (e. g. annual fuel and safety savings less operating costs)

For example: If the **ROI** is less than 20%, a second order level of analysis is required

2. The Present Worth Analysis (PWA)

The Present Worth Analysis incorporates the time value of money, generally as a discount factor.

The Benefit Cost Analysis provides a direct comparison of the present savings (properly discounted and summed over the expected lifetime) with the initial costs.

A benefit/cost ratio > 1 shows a profitable investment.

The present savings is determined using the tabulated present worth factors given in the following table

Present Worth Factors (PWF)					
	Discount Rate (D)				
Life time	**5%**	**10%**	**15%**	**20%**	**25%**
1	0.952	0.909	0.87	0.833	0.8
2	1.859	1.736	1.626	1.528	1.44
3	2.723	2.487	2.283	2.106	1.952
4	3.546	3.17	2.855	2.589	2.362
5	4.329	3.791	3.352	2.991	2.689
6	5.076	4.355	3.784	3.326	2.951
7	5.786	4.868	4.16	3.605	3.161
8	6.463	5.335	4.487	3.837	3.329
9	7.108	5.759	4.772	4.031	3.463
10	7.722	6.145	5.019	4.192	3.571
11	8.306	6.495	5.234	4.327	3.656
12	8.863	6.814	5.421	4.439	3.725

Present Worth Factors (PWF)

	Interest rate (D)				
Life time	**5%**	**10%**	**15%**	**20%**	**25%**
13	9.394	7.103	5.583	4.533	3.78
14	9.899	7.367	5.724	4.611	3.824
15	10.38	7.606	5.847	4.675	3.859
16	10.838	7.824	5.954	4.73	3.887
17	11.274	8.022	6.047	4.775	3.91
18	11.69	8.201	6.128	4.812	3.928
19	12.085	8.365	6.198	4.843	3.942
20	12.462	8.514	6.259	4.87	3.954
21	12.821	8.649	6.312	4.891	3.963
22	13.163	8.772	6.359	4.909	3.97
23	13.489	8.883	6.399	4.925	3.976
24	13.799	8.985	6.434	4.937	3.981
25	14.094	9.077	6.464	4.948	3.985

$$PWF = \frac{1 - (1 + D)^{-EL}}{D}$$

PWF = factor applied to determine present worth of future savings (PV)
D = Interest rate expressed as a fraction
EL= Expected Lifetime of the project in years

Study Case # 1

Data

- First Cost of Boiler (FC) = $ 500,000
- Annual Fuel Savings (AFS) = $ 130,500 = 30,000 MMBtu
- Annual Safety Saving (ASS) =$ 0
- Annual Saving by Optimization (ASA) = $ 0
- Annual Operating & maintenance Costs (AOMC) = $ 0
- Projected Fuel Price (PFP) = $ 4.35 / MMBtu
- Net Annual Savings (S) = (AFS + ASS + ASA) – AOMC
  = $ 130,500/year
- Net Annual Savings (S) **= $ 130,500 per year**
- Discount Rate (DR) = 20%
- Expected Lifetime (EL) = 12 years
- Present Worth Factor (PWF) = 4.439

1. Payback period (No discounting)

PP = FC/S = 500,000/130,500 = **3, 8 years**

Return on Investment

DC = FC/EL = $ 500,000/ 12 yr = 41,666 per year

ROI = **(S – DC) / FC x 100 %** =
(130,500 $/yr - 41,666 $/yr) / $ 500,000 x 100 % = **17.7 % per year**

ROI = 17.7 % per year

Our ROI is less than 20% (our criteria).

Therefore, a second order level of analysis is required.

Benefit/Cost Analysis

PV = Present Value (Worth of future savings for a given discount rate)

PV = S × PWF = $130,500 × 4.439 = $ 579,289.5

B/C = PV / FC = $ 579,289.5 / 500,000

B/C = 1.16

Time to recover the investment can be quickly approximated by using the table and the payback period (PP) estimated earlier as **3.8 years**.

In the 20% discount rate column, we can find that the present worth factor (PWF) closest to 3.8 is 3.837, which indicates that the investment will be entirely recovered in about **8 years** when taking the time value of money into consideration.

Study Case # 2

A hazardous event may result in an explosion at the boiler room that will cause an estimated **$ 1,000,000** in equipment damage.

An analysis showed that the expected frequency of this event is **1/500** per year.

The proposed safety system XXXX provides a risk reduction factor (RRF) of **100** will reduce the overall risk to **1/50,000** per year.

Assuming an expected **20** year life of the proposed safety system and an interest rate of **6%**

Question:

What level of initial expenditure can be justified for the system?

If our proposed safety system reduces the risk from **1/500** per year to **1/50,000** per year.

On average, the annual saving will be **$2,000 - $20** per year = **$ 1,980 per year.**

The highest amount of money we can justify for a safety system will be the present value (PV) of our investment that makes **20 annual payments of $1,980** at an interest rate of 6%.

PV= $1,980 x (1- (1.06) ^-20))/0.06 =

PV= $ 22,710 (*)

* The above solution assumes the operation and maintenance costs of safety system are negligible.

Study Case # 3

If we add to Study Case #1 this $ 1,980 as an annual cost for the improvement of the safety system and an annual operation and maintenance cost of $ 10,000 we can recalculate the new payback period (no discounting), return on investment and benefit/cost analysis ratio.

First Cost of Boiler (FC) = $ 500,000
Annual Fuel Savings (AFS) = $ 130,500 = 30,000 MMBtu
Annual Safety Saving (ASS) =$ 0
Annual cost for improvement of Safety System (ACISS) = $ 1,980
Annual Operating & Maintenance Costs (AOMC) = $ 10,000
Projected Fuel Price (PFP) = $ 4.35 /MMBtu
Net Annual Savings (S) = AFS – ACISS -AOMC = $ 130,500 – 1,980 -10,000
Net Annual Savings (S) **= $ 118,520 per year**
Discount Rate (D) = 20%
Expected Lifetime (EL) = 20 years
Present Worth Factor (PWF) = 4.87

Payback period (No discounting)

PP = **FC/S** = 500,000/118,520 = **4.21 years**

Return on Investment

DC = FC/EL = $ 500,000/ 20 yr =$ 25,000 per year

ROI = **(S – DC) / FC x 100 %** = (118,520 $/yr – 25,000$/yr) / $ 500,000 x 100 % =

ROI = 18.7 % per year

Our ROI is less than 20% (our criteria).

Therefore, a second order level of analysis is required.

Benefit/Cost Analysis

PV = S × PWF = $118,520 × 4.87 = $ 577,192.4

B/C = PV/FC = $ 577,192.4 / 500,000

B/C = 1.14

The expenditure is justifiable since the benefit is greater than the cost

Time to recovery the investment can be quickly approximated by using Table and the payback period (PP) estimated earlier as 4.2 years.
In the 20% discount rate column, we can find that the present worth factor closest to 4.2 is 4.192, which indicates that the investment will be entirely recovered in about 10 years when taking the time value of money into consideration.

Conclusions

Occupational Health & Safety and Process Safety are both part of overall System Safety, but they are separate and distinct from one another

The line from Occupational Health & Safety to Process Safety should be solid indicating an strong link

Safety professionals are one component of the multidisciplinary management organization found in industry. These functions cannot be accomplished in isolation.

Conclusions (Cont)

Safety professionals are interdependent or cross-functional with other functions of the management structure

The process of interacting with other areas such as Maintenance, Operation, Quality Processes, etc. provides to safety professionals an excellent opportunity for discussion of hazard identification, and suggesting both engineering changes and the correct operating procedures to prevent injuries.

Safety professionals should be able to not only perform their required activities associated with OHS but also possess the knowledge to understand the "why" of those activities and the capability to pursue life-long learning as safety professionals.

Thank you so much

Questions