Cost Benefit Analysis (CBA) Checklist

http://www.hse.gov.uk/risk/theory/alarpcheck.htm

This is a summary of the Health and Safety Executive (HSE) view of what should and should not be considered in a duty holder's CBA for health and safety ALARP ("as low as reasonably practical") determinations.

A CBA can help a duty holder make judgements on whether further risk reduction measures are reasonably practicable.

Something is reasonably practicable unless its costs are **grossly disproportionate** to the benefits. Put simply if;

$$\frac{\text{Costs}}{\text{Benefits}} > 1 \times \text{DF}$$

where DF is the 'disproportion factor' then the measure can be considered not worth doing for the risk reduction achieved. DFs that may be considered gross vary from upwards of 1 depending on a number of factors including the magnitude of the consequences and the frequency of realising those consequences, i.e. the greater the risk, the greater the DF. General points for a CBA presented as part of an ALARP demonstration:

- A CBA cannot be used to argue against the implementation of relevant good practice, unless the alternative measures are demonstrated unequivocally to be at least as effective.
- The depth of analysis should be fit for purpose, i.e. more rigour is required where the risk is higher or the consequences themselves are great e.g. multiple fatalities.
- A sensitivity analysis is usually required to support any conclusions suggesting that the costs are disproportionate to benefits of implementing a measure.
- A CBA on its own;
    - Does not constitute an ALARP case
    - Cannot be used to argue against statutory duties
    - Cannot justify risks that are intolerable, or justify what is evidently poor engineering.

Costs

HSE's main interest in assessing CBAs is to ensure that all the appropriate costs have been included and to challenge where costs appear extraneous or excessive.

- It would be proper to include the costs of installation, operation, training and any additional maintenance, and the business losses that would follow from any shutdown of the plant undertaken solely for the purpose of putting the measure into place.
- All claimed costs must be those incurred by the duty holder (costs incurred by other parties, e.g. members of the public should not be counted)
- Sacrifice implies non-recoverable cost e.g. if a measure implies lost production only the lost production during the delay can be counted.
- If lost production is actually deferred production (i.e. the life of the plant is based on operating rather than calendar time) then it should only take account of "interest" on the lost production plus allowance for operational costs during the implementation time and potential increase in operational costs at the end of life. (For example oil or

gas remaining in an oil/gas field while work is carried out on a platform should not be counted as lost production).

- If the lost production costs are a strong influence on a decision not to implement, the duty holder should show that phasing or scheduling the work to coincide with planned downtimes (e.g. for maintenance) would not change the balance.
- The costs considered should only be those necessary and sufficient for the purpose of implementing the risk reduction measure (no gold plating or deluxe measures)
- Ongoing production losses as a result of the measure (e.g. if things are slowed down or the new plant requires more maintenance) can be counted.
- Any savings as a result of the measure (e.g. reduced operational costs, avoidance of damage and reinstatement costs if relevant) should be offset against the above costs. These are not considered safety benefits but are counted as ‘ cost savings’ i.e. they reduce the overall cost of implementing a measure.
- The costs claimed should be shown only to relate to the measure being implemented for safety.
- Translation into monetary costs is often uncertain and all should be justified.

Benefits

HSE’s main interest is to ensure that all benefits of implementing a health and safety improvement measure are included and that the benefits associated with the measure are not underestimated in any way.

- The benefits should include all reduction in risk to members of the public, to workers and to the wider community. I.e. benefits can be broken down into prevented:
    - Fatalities
    - Injuries (major to minor)
    - Ill health
    - Environmental damage if relevant (e.g. COMAH)
- Benefits can include avoidance of deployment of emergency services and avoidance of countermeasures such as evacuation and post accident decontamination if appropriate.
- The cash valuations of preventing health and safety effects on people are presented in the table below;

		Values (2003 Q3) [1]
FATALITY		£1,336,800 (times 2 for cancer)
INJURY		
Permanently incapacitating injury	Moderate to severe pain for 1-4 weeks. Thereafter some pain gradually reducing but may recur when taking part in some activities. Some permanent restrictions to leisure and possibly some work activities.	£207,2000
Serious	Slight to moderate pain for 2-7 days. Thereafter some pain/discomfort for several weeks. Some restrictions to work and/or leisure activities for several weeks/months. After 3-4 monthsreturn to normal health with no permanent disability.	£20,500
Slight	Injury involving minor cuts and bruises with a quick and	£300

	complete recovery.	
ILLNESS		
Permanently incapacitating illness	Same as for injury.	£193,100
Other cases of ill health	Over one week absence. No permanent health consequences.	£2,300 + £180 per day of absence
Minor	Up to one-week absence. No permanent health consequences.	£530

- All benefits of a measure should be included. If a risk reduction measure is identified for one type of accident but reduces other risks as well e.g. health risks, all benefits should be counted.
- It should be noted that duty holders might need to treat re-instatement costs as a benefit rather than offsetting them against costs. This would be the case if the plant being re-instated were a safety related plant (e.g. one that treats hazardous waste). This can represent a bias **in favour** of safety. This is because the gross disproportion factor is applied to all benefits prior to them being compared to the costs.

Analysis features

There are a number of features within an analysis that can have influence on the outcome. The following points should be considered when assessing the suitability of a CBA.

- Discounting of monetary values to translate future benefits/costs to present values is permitted.
- If there are significant future costs, a duty holder must consider discounting to see if this might change the outcome of a finely balanced analysis, i.e. where a measure is deemed not reasonably practicable without discounting they need to show that the outcome would not differ if discounting was applied. Discounting of future costs, particularly if they are significant, may make a measure more favourable than if discounting was ignored. This is because higher effective discount rates are applied to costs than to health and safety benefits.
- Future health and safety benefits should not be discounted at rates greater than 1.5% (2003 figure).
- Future costs and cost savings should be discounted at a rate no less than 3.5% (2003 figure)
- Discount periods in excess of 50 yr are problematic and indications that a measure is not indicated as a result of such an analysis feature should be viewed with caution.
- The analysis should be shown to be robust by appropriate sensitivity analyses, in line with the precautionary approach. In particular, the results of any CBA associated with major accident hazards will be subject to uncertainty owing to the need to estimate how severe and how often the accidents might be. By their nature these accidents are rare but when they do happen, they can have very high consequences.
- In some cases the inputs to the CBA may have sensitivity ranges of factors of 3 or more. Unless the extreme value has been used in the analysis an outcome where the gross DF was exceeded by less than this factor would not be a compelling indication that the improvement was not reasonably practicable. Duty holders should provide adequate justification that they have used conservative inputs to the CBA or that the sensitivity range factors are appropriate.
- The analysis should justify an appropriate DF.

- In the event of a major accident occurring, significant issues for duty holders include:
    - Reputation
    - Share price
    - Customer base and market share.

Although these issues are not ones that HSE would require a duty holder to consider they can often play a significant part of any judgement on whether to invest in new and safer technology.

Example

A simple method for coarse screening of measures is presented below. This puts the costs and benefits into a common format of '£s per year' for the lifetime of a plant.

Consider a chemical plant with a process that if it were to explode could lead to:

- 20 fatalities
- 40 permanently injured
- 100 seriously injured
- 200 slightly injured

The rate of this explosion happening has been analysed to be about 1 x 10-5 per year, which is 1 in 100,000 per year. The plant has an estimated lifetime of 25 years.

How much could the company reasonably spend to eliminate (reduce to zero) the risk from the explosion?

If the risk of explosion were to be eliminated the benefits can be assessed to be:

Fatalities:	20	x 1,336,800	x 1 x 10^{-5}	x 25 yrs	=6684
Permanent injuries:	40	x 207,200	x 1 x 10^{-5}	x 25 yrs	= 2072
Serious injuries:	100	x 20,500	x 1 x 10^{-5}	x 25 yrs	= 512
Slight Injuries:	200	x 300	x 1 x 10^{-5}	x 25 yrs	= 15
Total benefits					= £9,283

The sum of £9,283 is the estimated benefit of eliminating the major accident explosion at the plant on the basis of avoidance of casualties. (This method does not include discounting or take account of inflation.)

For a measure to be deemed not reasonably practicable, the cost has to be grossly disproportionate to the benefits. This is taken into account by the disproportion factor (DF). In this case, the DF will reflect that the consequences of such explosions are high. A DF of more than 10 is unlikely.

Therefore it might be reasonably practicable to spend up to somewhere in the region of £93,000 (£9300 x 10) to eliminate the risk of an explosion. The duty holder would have to justify use of a smaller DF.

This type of simple analysis can be used to eliminate or include some measures by costing various alternative methods of eliminating or reducing risks.