CASE STUDY
Oil Spill Risk Analysis for VLCC

Very Large Crude Carrier (VLCC) is the industry name for a modern super tanker. These 250,000 draft weight tons (dwt) vessels presently cost about $90 million, can transport over 2 MMbbls at 16 knots, and charter for about $35,000 per day.

Oil tankers risk collision accidents. The risk is heightened if a tanker loss either its steering power or propulsion power.

We will be evaluating the **preventive maintenance program** reduce risks of system failure. Two levels of maintenance and the corresponding failure probabilities are:

	High Maintenance	**Low Maintenance**
Annual cost $million	1	0.8
Risk of Steering Loss / year	.001	.0015
Risk of Power Loss / year	.01	.02

Expected values for **tanker repair cost** including loss of service time are:

- $12 million if accident with an empty tanker
- $15 million if accident with oil but no spill
- $25 million if accident with an oil spill

The tanker has oil in it 50% of the time while at sea. If the tanker carrying has an accident, there is a 0.4 probability of an oil spill. The spill costs do not include the maintenance cost and repair cost. Assume the spill costs include as actual costs or cost-equivalents:

-Spill cleanup costs
-Damage to the environment
-Injuries
-Loss of life
-Loss of oil cargo
-Impact on corporate reputation or goodwill

The sizes and cleanup costs of oil spills scenarios are:

Spill size MMbbls	**Probability**	**Cleanup Cost $million**
0.01	**0.5**	**200**
0.1	**0.4**	**400**
1	**0.1**	**2,000**

Assume that all monetary amounts are present values and net of taxes.

The spill risks in these situations increases during bad weather. There is a 0.1 chance of rough weather.
The **probabilities of accident** as the conditional probabilities given failure type and weather conditions from the various combinations of weather and system failure are:

	Weather Conditions	
Failure	**Rough**	**Calm**
Steering	**0.1**	**0.03**
Power	**0.06**	**0.02**

Simplifying assumptions:

- Steering and power failure are independent of each other and independent of the weather.
- The probability of multiple failures during the same year is approximate zero. The probability is even less for both systems failing together.
- The long-term reliability of the tanker is not affected by the choice of maintenance program.
- The spill size and cleanup costs are not affected by the weather.
- Steering and power system repair costs are negligible.

Your assignment is to develop the decision tree to determine whether the company should invest the additional $0.2 million per year in a <u>High maintenance program</u> by:

a. Calculate E(cost of an accident)
b. Calculate E(cost of accident | High Maintenance)
c. Calculate E(cost of accident **|** Low Maintenance)

Calculate E(size spill | High maintenance). Does this provide ant insight to the maintenance decision?

Develop a decision tree for the problem if steering and power system reliabilities are affected by the weather.

Develop the decision tree where the spill cost is a function of weather.

Using the EMV decision rule, consider whether it would be appropriate to implement Low maintenance plus buy an accident insurance policy covering all incident costs:

- The policy costs $40,000 per year
- The claim deductible (first portion not covered) is $50 million.
- The maximum settlement is $900 million.