



Event Tree Analysis

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- Systematic and quantitative
- Inductive (search for consequences)

Objectives

1. Identification of possible scenarios (accident sequences), developing from a given accident initiator
2. Computation of accident sequence probability



• System event tree

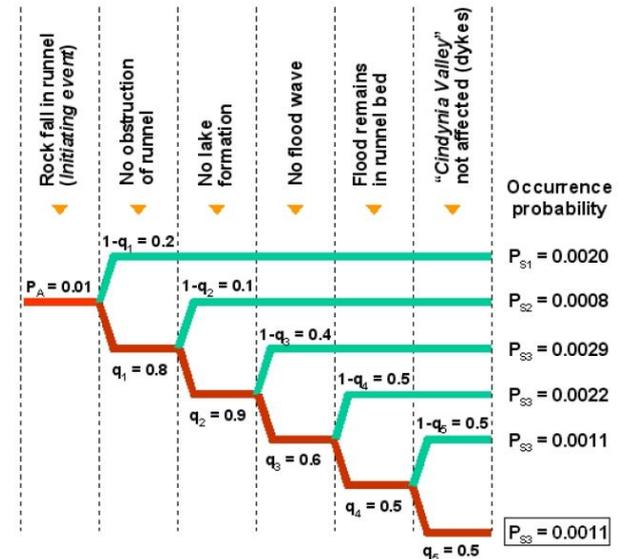
The accident sequences in the **system/infrastructure** are identified with respect to the protection and safety systems/components involved (valves, pumps, pipes, tanks, etc.)

Quantification of Event Tree for Building Protected by Sprinkler System

Initiating Event	Fire Spreads Quickly	Sprinkler Fails to Work	People Cannot Escape	Resultant Event	Scenario
Fire Starts	P = 0.1 YES	P = 0.3 YES	P = 0.5 YES	Multiple Fatalities	1
			P = 0.5 NO	Loss / Damage	2
Fire Starts	P = 0.1 NO	P = 0.7 NO		Fire Controlled	3
		P = 0.9 NO	Fire Contained	4	
Frequency = 1/yr					

• Phenomenological event tree

Description of the accident phenomenological evolution that **affect the system/infrastructure** (winds, sea currents, animals/plants, etc.)

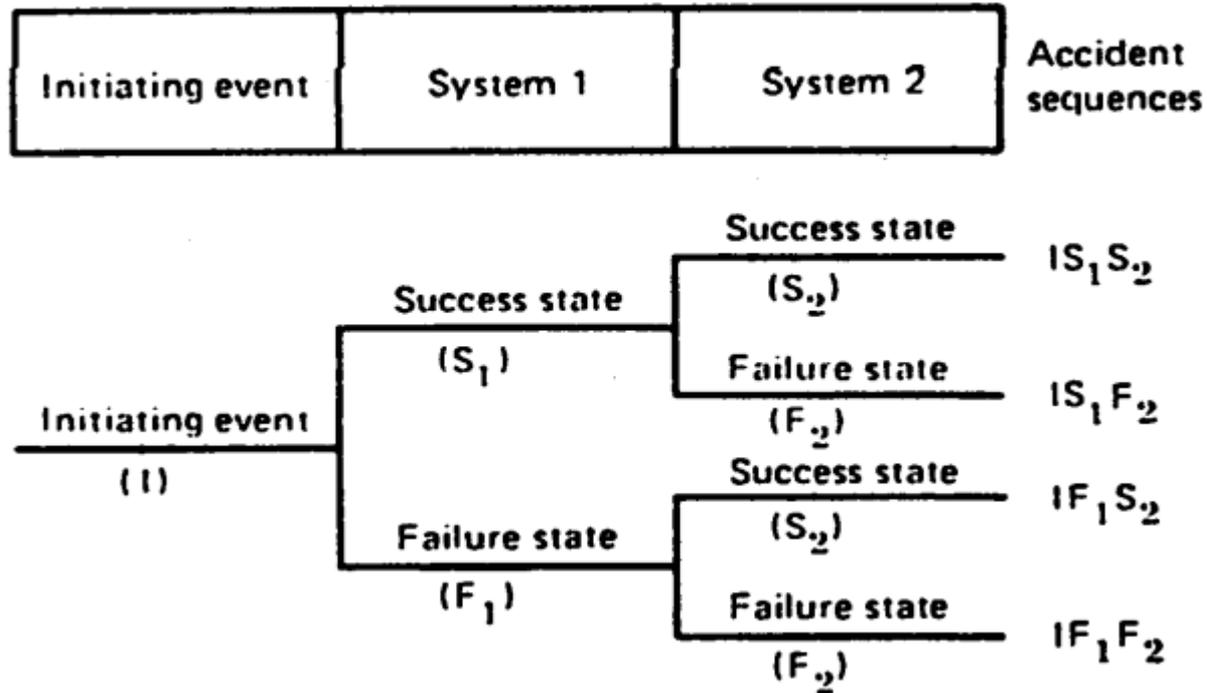




1. Define an accident initiator **I** (**initiating event IE**)
 - a system failure
 - an external, potentially disruptive event (e.g., an earthquake)
2. Identify “**headings**” S_k :
 - **safety/protection functions, systems, procedures** demanded by IE
 - **phenomena** potentially influencing the development of an accident sequence
3. Specify **failure/success** states of S_k
4. Combine the states of all S_k to generate accident sequences



Event Tree





Conditional probabilities are assigned to S_k states (upon previous identification, e.g. by **FTA**)

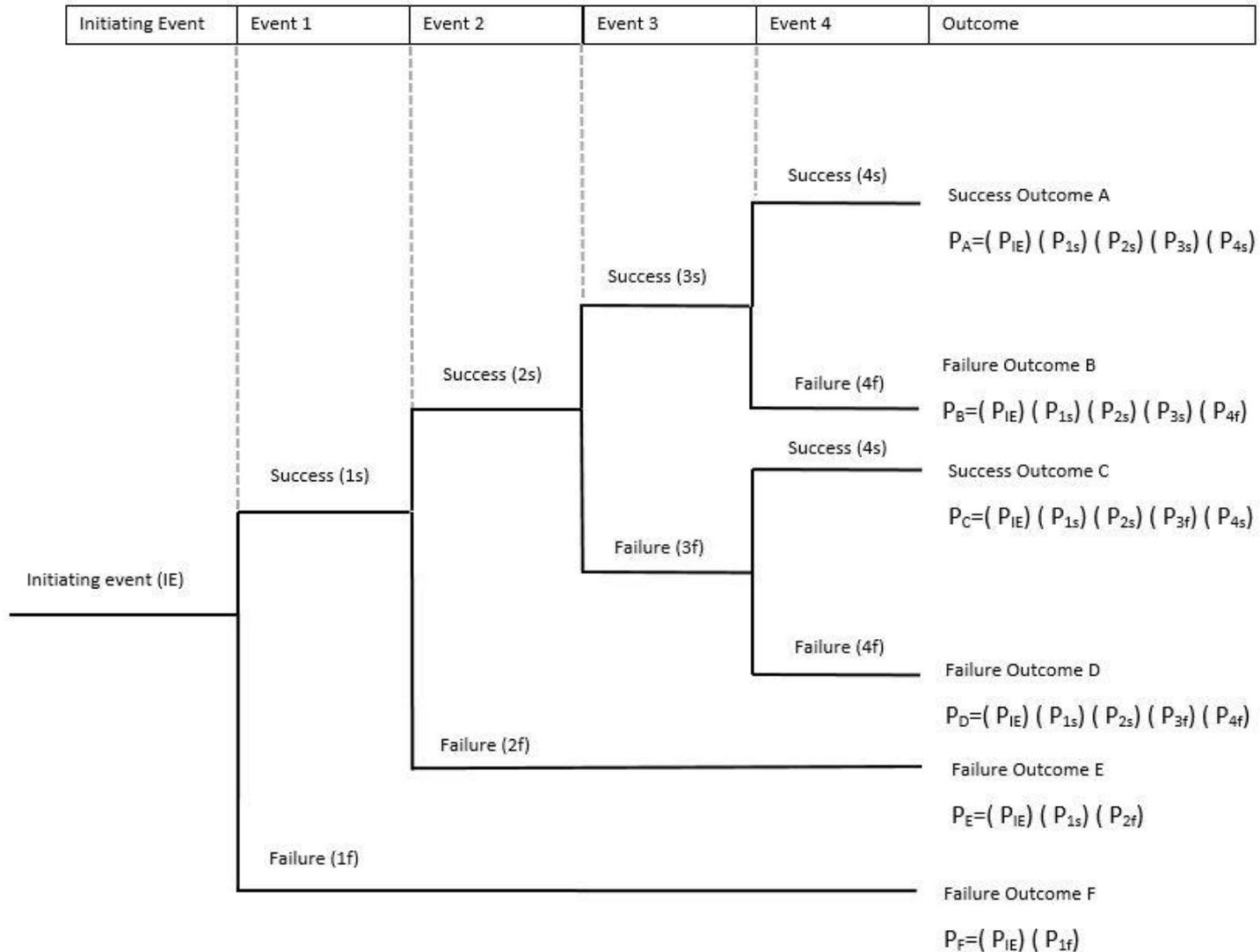


Sequence probability = product of the conditional probabilities of the events in a branch

“Failure” probability = sum of the probabilities of the sequences leading to failures

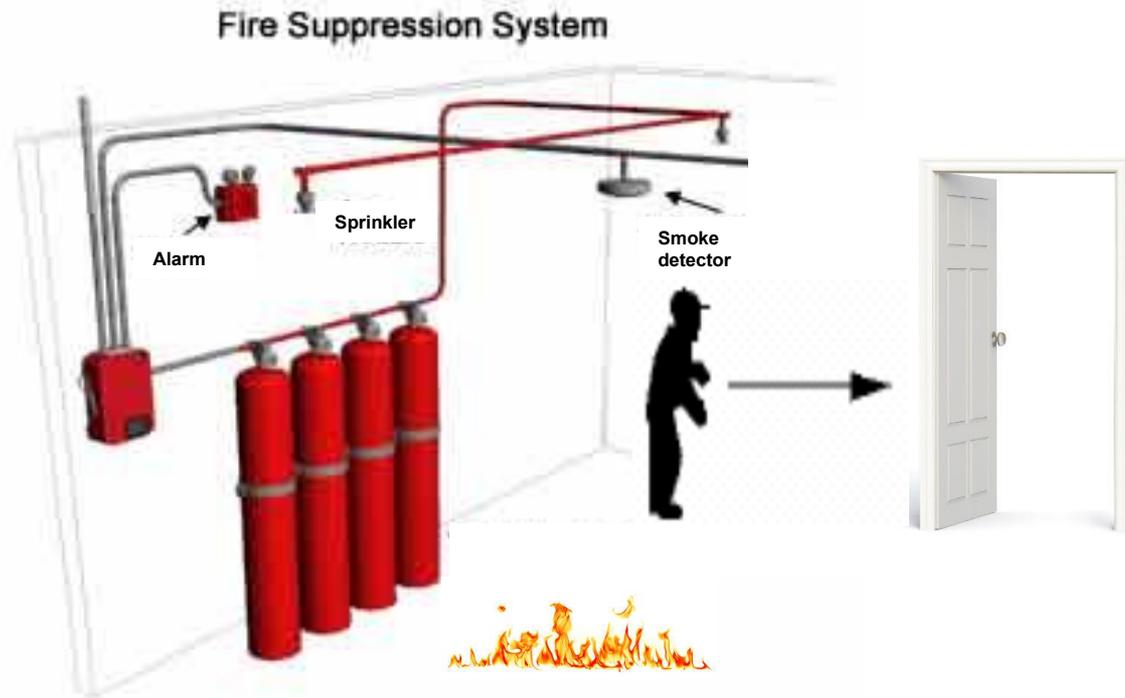


Event Tree (independent events)





Event Tree Example 1: Fire protection system





Event Tree Example 1: Fire protection system

**INITIATING
EVENT**

**FIRE SPREADS
QUICKLY**

**SPRINKLER
FAILS TO
WORK**

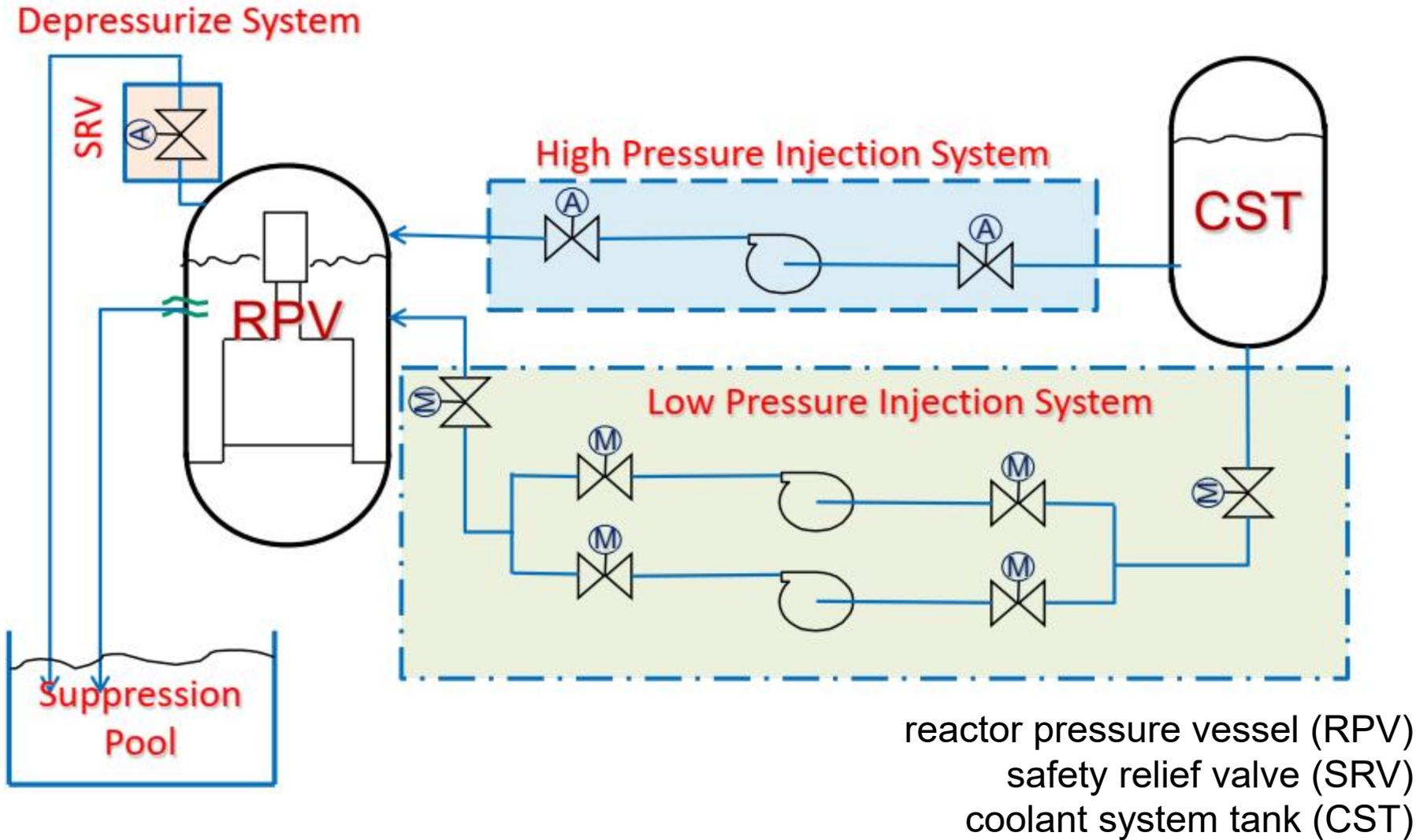
**PEOPLE
CANNOT
ESCAPE**

**RESULTANT
EVENT**

SCENARIO



Event Tree Example 2: Loss of coolant accident





Event Tree Example 2 (cont.)

- ❖ A small pipe crack can induce the loss of coolant (SLOCA) of the reactor pressure vessel (RPV). The frequency of this event is **5.0E-4**.
- ❖ Under the small loss of coolant accident (SLOCA) condition, the RPV water level drops due to the crack and decay heat. When it drops to a certain low level, the high pressure injection system (**HPIS**) starts to pump water into the core.
- ❖ In case that the **HPIS** works properly, the RPV can be depressurized under control and low pressure injection system (**LPIS**) will take care of long term heat removal to bring the core to safe status.
- ❖ If HPIS fails (at probability of **2.0E-3**), the water level goes down to another setting level and trigger-starts LPIS. Then the operator has to open the safety relief valve (SRV) to relief the RPV pressure (depressurization by SRV, **DPS**) in order to keep LPIS pumping the water into the core.
- ❖ In case either the operator fails to open SRV (at probability of **5.0E-3**) or **LPIS** fails (at probability of **5.0E-4**), the core will be damaged.

You are required to:

1. Build the Event Tree (ET) with initiating event “SLOCA”. The event headers are “HPIS”, “DPS” and “LPIS” and the possible consequences are “OK” and “Reactor core damage (CD)”.
2. Compute the probability of “Reactor core damage” given a SLOCA.

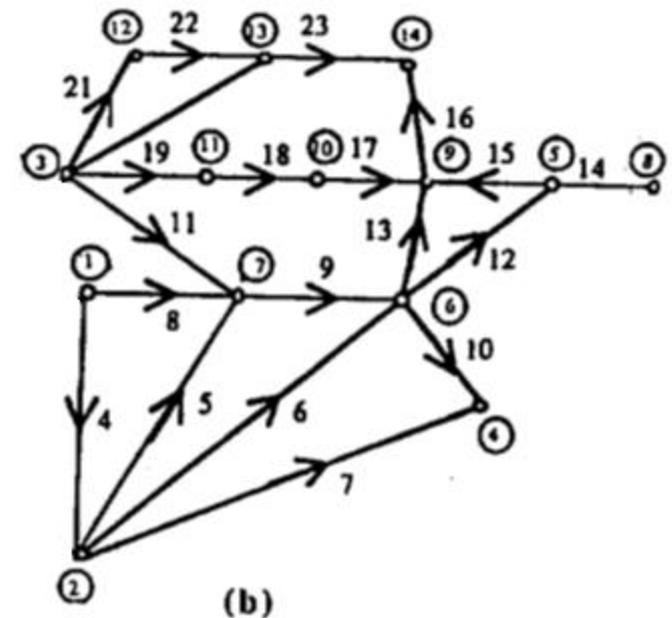
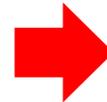
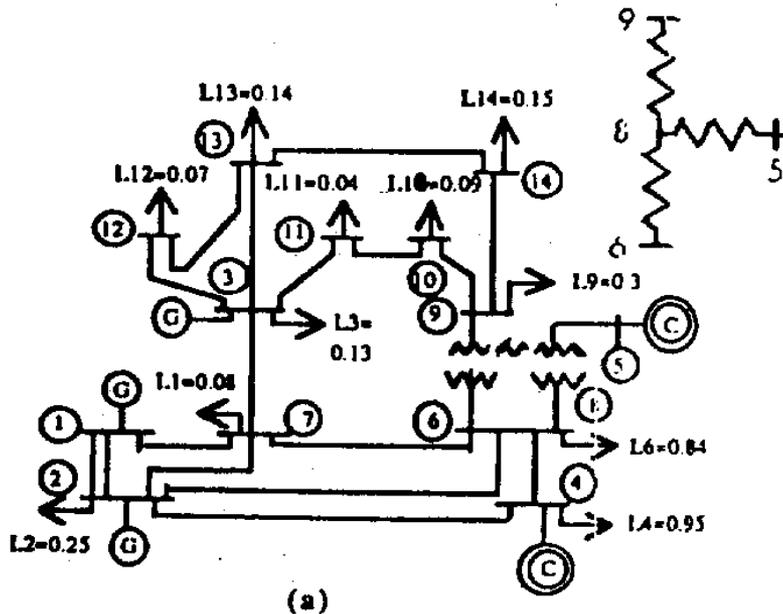


Event Tree Example 3: IEEE14 Bus Power Distribution System

Generators (G1, G2, G3)

Loads (2, 3, 4, 6, 7, 9, 10, 11, 12, 13, 14)

Power delivery paths: lines (L) and buses (B).





Event Tree Example 3: IEEE14 Bus Power Distribution System

Draw the ET and calculate the probability of “failure to supply power to bus 2” (Load2)

G1	B1	L4		G2	B2
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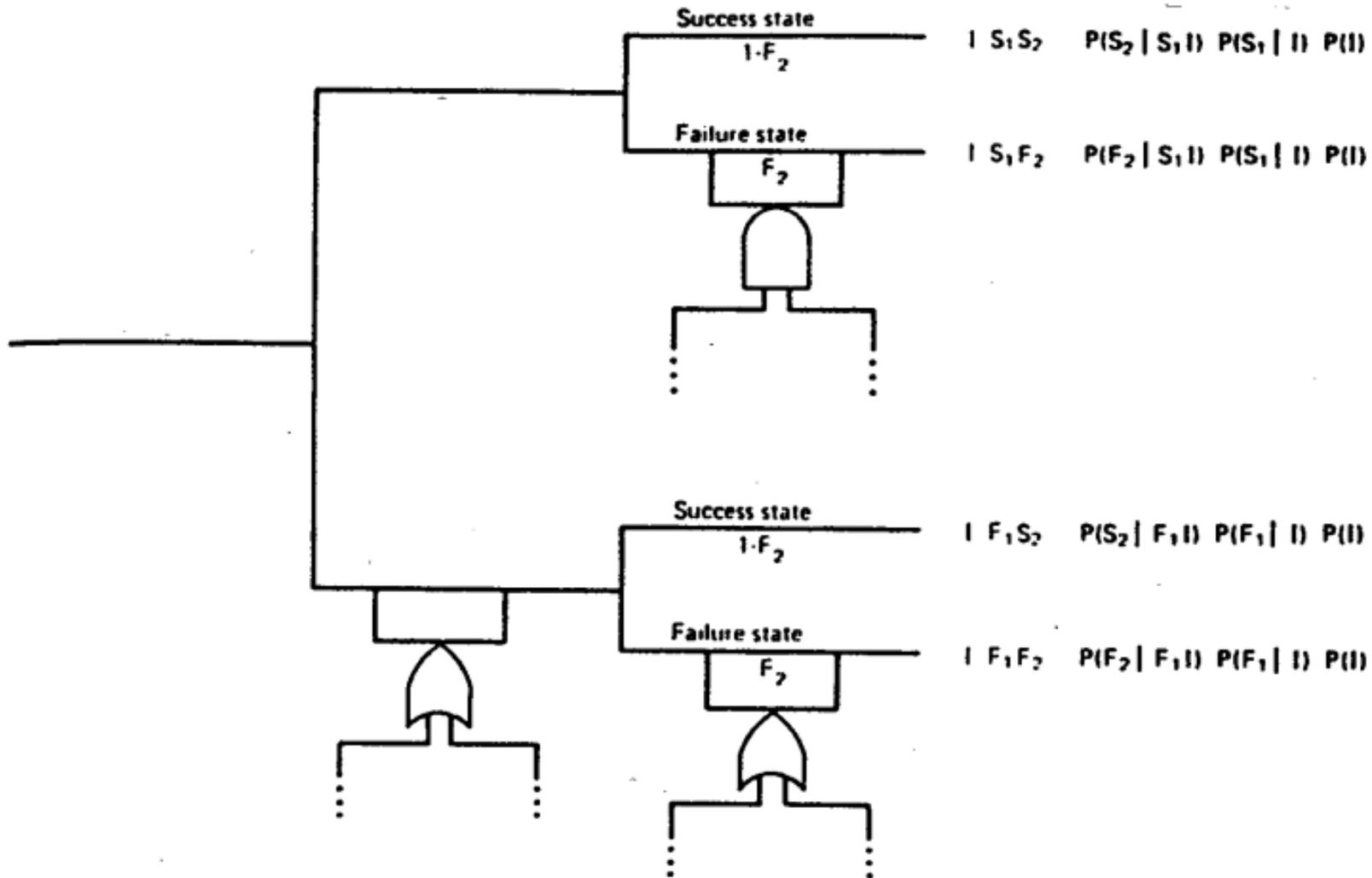
Failure probabilities:

- B1, B2: $p = 3.57 \cdot 10^{-4}$
- G1, G2: $p = 4 \cdot 10^{-2}$
- L4: $p = 2 \cdot 10^{-2}$



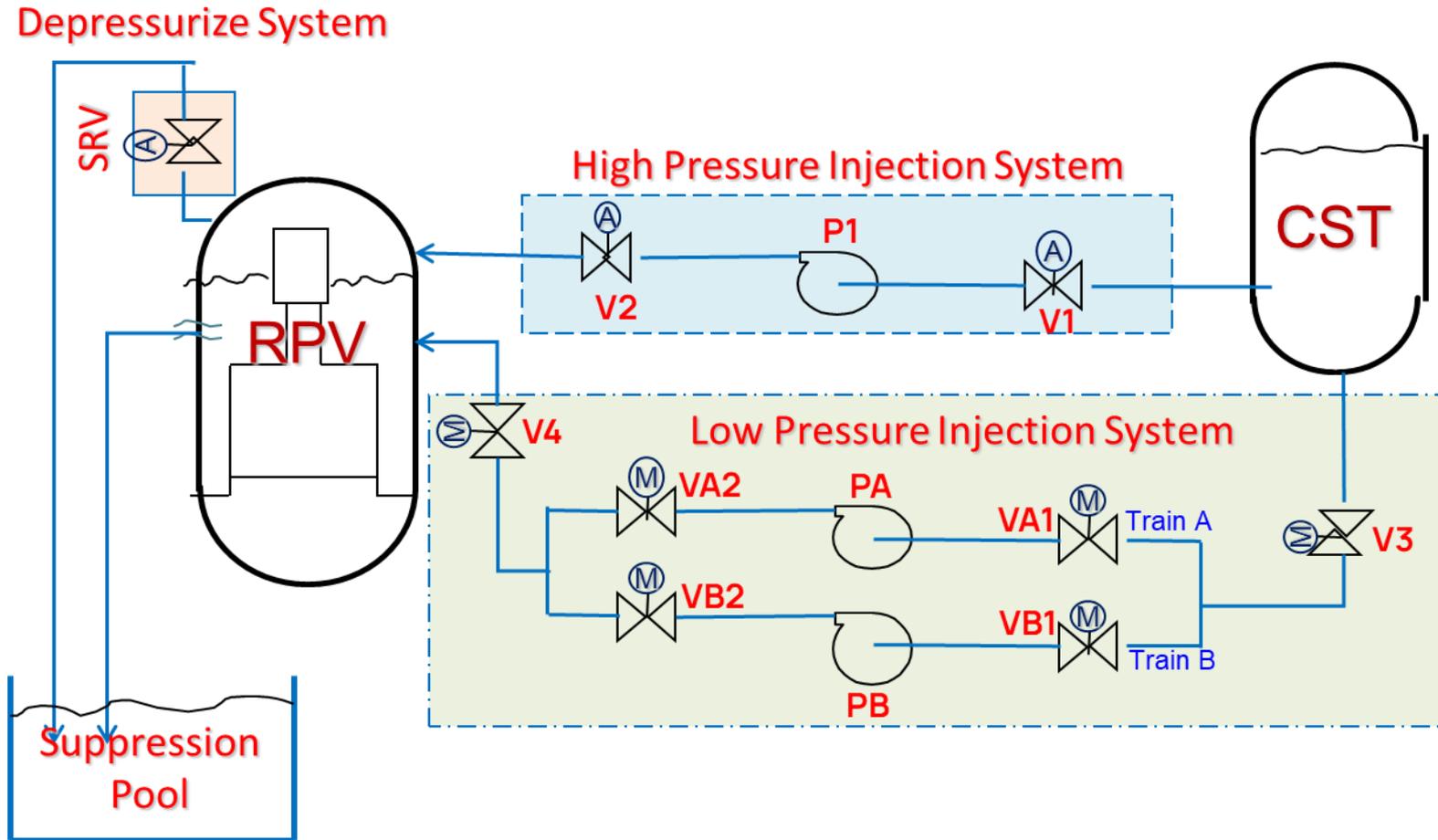
ETA: some general comments

1. One event tree for each accident initiator
2. **Time** and **logic** of S_k interventions are important for the tree structure (**simplifications possible**)
3. S_k states are, in general, **conditional** on accident initiator and previous S_j 's states
4. Conditional probabilities of S_k states (FTA)





Event Tree Example 2: Loss of coolant accident



1. Build the Event Tree (ET) with initiating event “SLOCA”. The event headers are “HPIS”, “DPS” and “LPIS” and the possible consequences are “OK” and “Reactor core damage (CD)”.
2. Build the Fault Trees (FT) for each of the HPIS, DPS and LPIS.

reactor pressure vessel (RPV)
safety relief valve (SRV)
coolant system tank (CST)