Master in Nuclear Engineering
REGULATION AND SAFETY
Probabilistic Safety Assessment

6'5/10

Test

June, 2014

Name: .....

1. Express the qualitative and quantitative objectives of Probabilistic Safety Assessment.

   Qualitative Describe the events dependancies that can lead to damage in the form of sequences through event tree

   Quantitative Asses as precisely as possible the value of the Risk of damage (i.e. core damage for NPP) in terms of damage in time through fault tree

2. Define Initiating Event (initiator) for at-power PSA, and give two examples.

   Def Abnormal occurence that trigggers a sequence of events that can lead to damage.

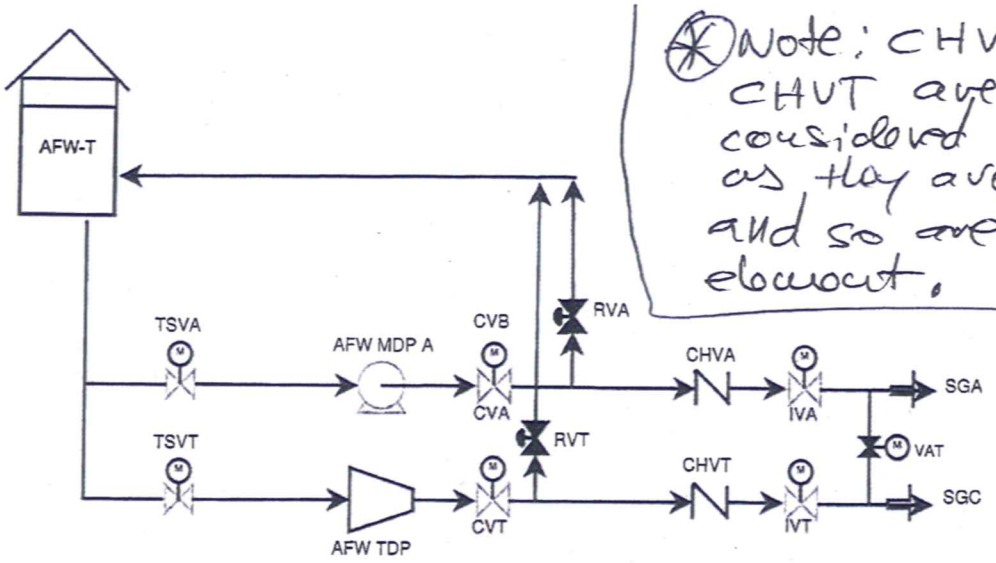
   Ex 1 Turbine trip

   Ex 2 LOOP (Loss of offsite power).

3. Draw the fault tree for Top Event *Failure to provide flow to at least one steam generator*, where

   - Valves RVA and RVT are depicted solid; thus they are normally closed. Failure to remain closed may endanger the system success criterion.
   - Valves depicted void are normally open. Failure to remain open may endanger the system success criterion.
   - Check valves are expected to open.
   - If recirculation valves RVA and RVT are left open after testing, flow will be diverted to the tank.

*Note: CHVA and CHVT are not considered to fail as they are clockwise and so are a passive element.



could not provide flow to at least one SG

TOP EVENT

VAT fails to open

RVA accidentally opens

IVA accidentally closes

IVT accidentally closes

RVT accidentally opens

TSVA closes accidentally

AFW MDPA NOT OPERATED

CVA closes accidentally

TSVT closes accidentally

AFW TDP NOT OPERATED

CVT closes

4. Classify the following human actions:

Cat. 1 Operator error to close a BWR Safety/Relief valve before SCRAM is required.

Cat. 3 Operator failure to open a Steam Generator relief valve to reduce pressure and temperature, following EOP E-3 (Steam generator tube rupture).

Cat. 3 Turbine operator failure to operate Diesel generator startup handles, as required by ECA-0.0.

Cat. 5 Maintenance personnel error while making the change from A to B service air system that provokes a loss of service air causing the closure of Main Feedwater isolation valves that in turn leads to a reactor trip on low-low steam generator level.

5. Mark Yes (Y) or No (N) according to whether the following event would be considered as a failure for PSA. Explain your reasoning.

N During a DG startup for a Tech Specs 24 hour Surveillance Requirement, a small oil leak is observed. The leak is observed to increase in time by 0.01l/min/min. One hour into the test, the DG is shutdown for repair. A leak of 10l/min is larger than the makeup capacity of the oil pump and thus unacceptable.

The leakage observed coming out of the DG is produced during a test, though not real conditions of danger. The repair is considered to be classified as corrective maintenance. No initiating event has been defined so the PP is safe.

6. Explain what is the unavailability of equipment due to test or maintenance.

Availability, or other its opposite: unavailability, is understood as percentage of time or absolute hours during a normal year that the specific equipment could not work because it will be under supervision or either under preventive or corrective maintenance works

7. Define *Minimal Cut Set* for the Core Damage Equation and explain its elements.

It is the most simplified boolean expression that expresses the probability of the above mentioned Core Damage as a product of sums of the captions of an

8. Minimize the following boolean equation.

$$F = (A+B+C)\cdot(B+C)+(C+D)\cdot(D+A)+(D+C)\cdot(C+E)$$

1. $A(B+C)+B(B+C)+C(B+C)+C\cdot(D+A)+D(D+A)+(D+C)(C+E)$
2. $A(B+C)+B+C+C(D+A)+D+D(C+E)+C(C+E)$
3. $A(B+C)+B+C+C(D+A)+D+D(C+E)+C$
4. $AB+AC+B+C+CD+CA+D+DC+DE+C$
5. $AB+AC+C+B+CD+D$ → absorption.
6. $B+C+D$