

FTA()

KSA TPM

/

權五運

1. FTA()

98 4

FMEA

, TPM

FMEA,

FTA(故障木

, 缺陷樹

),

가

, PM

FMEA

FMECA

가

, FMEA

FMECA

FTA

(top down)

()

,

가

가

가

FTA

1962

Bell

W. A. Watson

, 1965

Kolodner

FTA

(block diagram)

, 1965

D. F. Hassl

, ICBM

FTA

2. FTA

FTA

가

, FTA

1: 가

()

2:

3: Event()

4:

5:

6: 가

(Event)

Boolean()

7:

3. (Fault tree)

FT

(event)

(top event),

頂上

()

()

가

FT

通常 ()
()

()

(FT)

轉移

4. ()

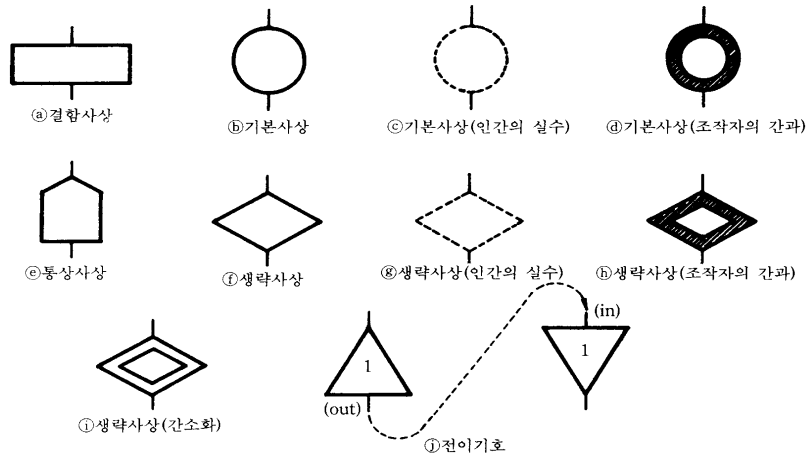
AND
(modifier)

OR

가

:
()
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(),
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< 1 >



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()

가
(,).

가
().

: FT

가 ()

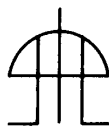
AND

OR

< 2>

AND

OR



(inhibit gate) :

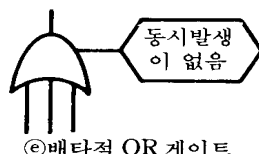
(modifier)

(inhibit modifier)

(not gate):

(not modifier)

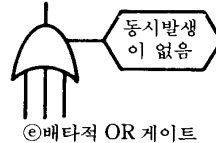
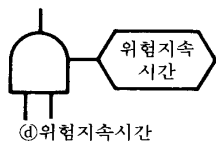
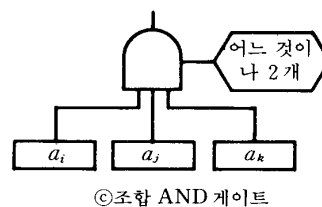
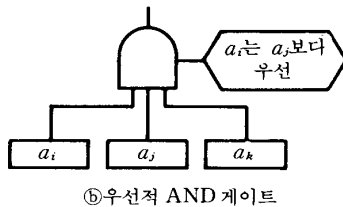
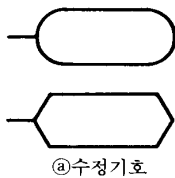
< 3>



AND

OR

< 4>



AND (priority AND gate, sequential AND gate) :

AND (combination AND gate) : 3

2 가

(hazard duration modifier) :

OR (exclusive OR gate): 2

5.

AND Gate

$$F_A = F(B \text{ AND } C) = F(B \cap C)$$

$$B \quad C \text{가} \quad \therefore F_A = F_B \cdot F_C$$

$$F_A = 1 - R_A = 1 - [1 - (1 - R_B)(1 - R_C)] = (1 - R_B)(1 - R_C) = F_B \cdot F_C$$

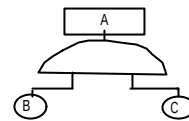
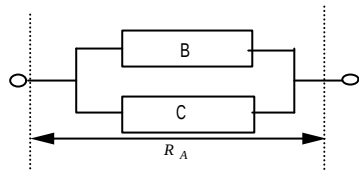
, n AND .

$$F_S = F_1 \cdot F_2 \cdots F_n = \prod_{i=1}^n F_i$$

< 5>

< 6> AND

FT



OR Gate

$$F_A = F(B \text{ OR } C) = F(B \cup C)$$

$$(B \quad C \text{가}) \quad \therefore F_A = F_B + F_C - F_B \cdot F_C$$

$$(F_B = 1 - R_B, F_C = 1 - R_C) \quad \therefore F_A = 1 - (1 - F_B)(1 - F_C)$$

$$F_A = 1 - R_A = 1 - R_B \cdot R_C = 1 - (1 - F_B)(1 - F_C) = F_B + F_C - F_B \cdot F_C$$

n OR

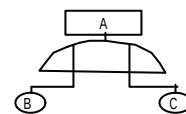
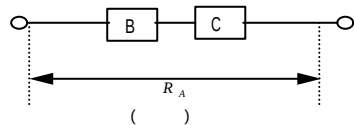
$$F_S = 1 - (1 - F_1)(1 - F_2) \cdots (1 - F_n)$$

$$= 1 - \prod_{i=1}^n (1 - F_i)$$

< 7>

< 8> OR

FT



(OR Gate)

A

F_A

B, C

F_B, F_C

,

F_B

.

$$R(t) = e^{-\lambda t} = e^{-t/MTBF} \approx 1 - \frac{t}{MTBF} \quad (, \quad t)$$

B가

F_B

$$F_B = 1 - R_B = 1 - (1 - \frac{t}{MTBF}) = \frac{t}{MTBF} \quad (< 1)$$

t (가) , R_B B

$MTBF$ () .

$$MTBF = \frac{1}{I} = \frac{(T)}{(r)}$$

$MTBF$ (F_S)
 $MTBF$ F_S $MTBF$ ($\uparrow$) $\rightarrow R(t)$ ($\uparrow$) $\rightarrow F(t)$ ($\downarrow$) $\rightarrow F_S$ ($\downarrow$) .

6. FT圖

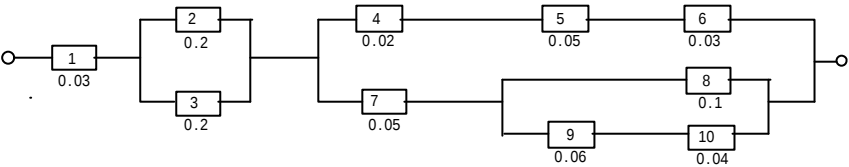
1
 가 < 9> , < 10>FT

(1) (,)
 $F_{S1} = 1 - (1 - F_9)(1 - F_{10}) = 1 - (1 - 0.06)(1 - 0.04) = 0.098$

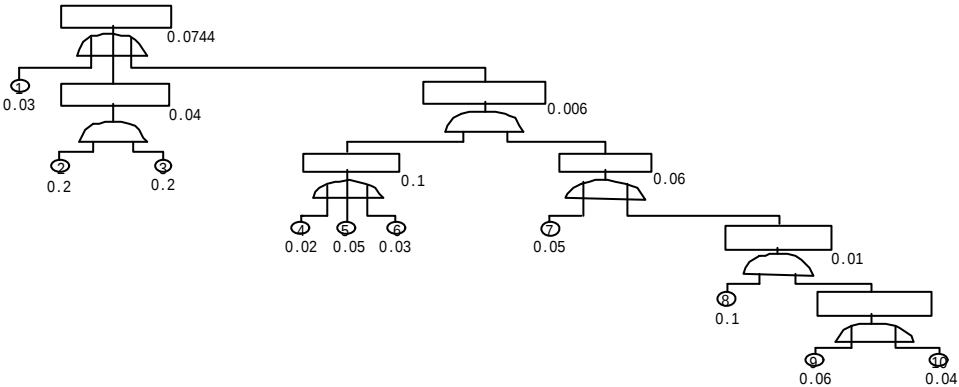
(2) (, ,)
 $F_{S2} = F_8 \cdot F_{S1} = 0.1 \times 0.098 = 0.01$

(3)
 $F_{S3} = 1 - (1 - 0.02)(1 - 0.05)(1 - 0.03) \times 1 - (1 - 0.05)(1 - 0.01) = 0.1 \times 0.06 = 0.006$

(4)
 $F_S = 1 - (1 - 0.03)(1 - 0.2 \times 0.2)(1 - 0.006) = 0.0744$
 < 9> 1

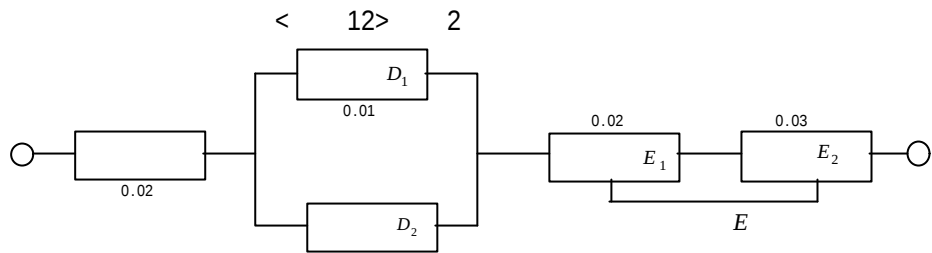
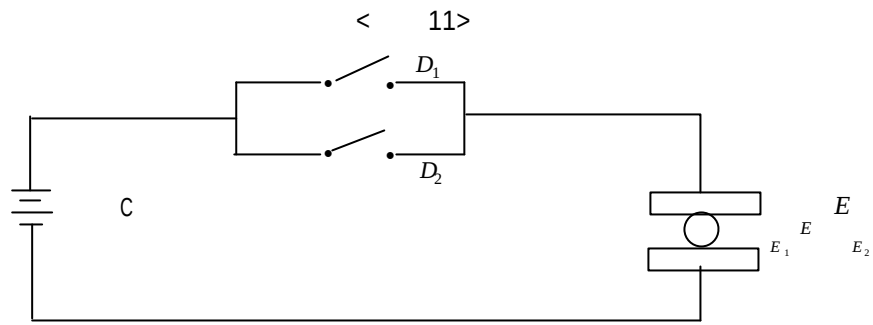


< 10> 1 FT



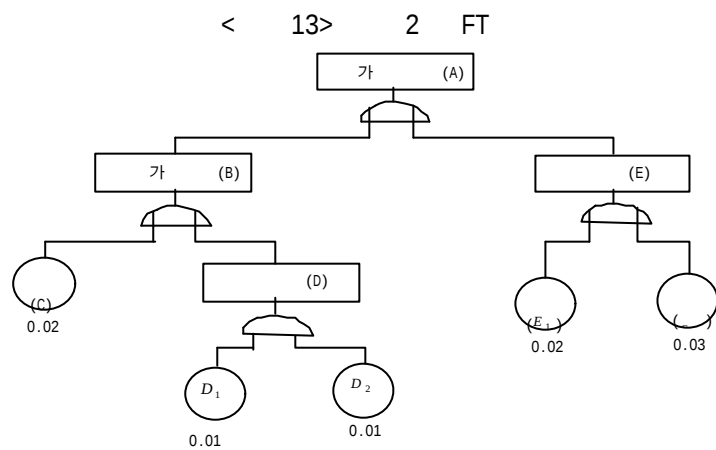
2

< 11> FTA (,
 「 가 」



< 12>

< 13> FT () 「 가 」



「 가 」 頂上

$$F_D = F_{D1} \cdot F_{D2} = (0.01)(0.01) = 0.0001$$

$$F_B = 1 - (1 - F_C)(1 - F_D) = 1 - (1 - 0.02)(1 - 0.0001) = 1 - (1 - 0.02)(1 - 0.0001) \\ = 1 - 0.9799 = 0.0201$$

$$F_E = 1 - (1 - F_{E1})(1 - F_{E2}) = 1 - (1 - 0.02)(1 - 0.03) = 1 - 0.9506 = 0.0494$$

$$F_A = 1 - (1 - F_B)(1 - F_E) = 1 - (1 - 0.0201)(1 - 0.0494) = 1 - 0.9315 = 0.0685$$

7. FMEA FTA

FMEA FTA

FMEA

(chart)

(FTA)

(FTA)

FMEA

()

, FTA

FMEA

, FTA