

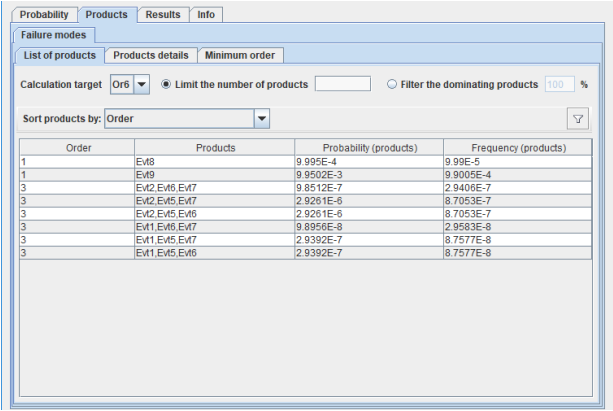
BOOLEAN MODULES 2018



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MINIMAL CUT-SET FREQUENCY



The screenshot displays the 'Probability' tab of the SATODEV software. It shows a table of minimal cut-sets with columns for Order, Products, Probability (products), and Frequency (products). The table lists several cut-sets, with the first one being 'Ev9' and the last one being 'Ev1.Ev5.Ev6'.

Order	Products	Probability (products)	Frequency (products)
1	Ev9	9.995E-4	9.99E-5
1	Ev9	9.9502E-3	9.9005E-4
3	Ev2.Ev6.Ev7	9.8512E-7	2.9406E-7
3	Ev2.Ev5.Ev7	2.9261E-6	8.7053E-7
3	Ev2.Ev5.Ev6	2.9261E-6	8.7053E-7
3	Ev1.Ev6.Ev7	9.8956E-8	2.9583E-8
3	Ev1.Ev5.Ev7	2.9392E-7	8.7577E-8
3	Ev1.Ev5.Ev6	2.9392E-7	8.7577E-8



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MINIMAL ORDER OF MINIMAL CUT-SET

Event	Minimum order
Ev8	1
Ev9	1
Ev11	2
Ev10	2
Ev12	3
Ev6	3
Ev7	3
Ev5	3



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BARLOW PROCHAN IMPORTANCE FACTOR

- Frequency importance factor by Richard E Barlow et Frank PROSCHAN in 1974

$$BP(S, C, t) = \frac{W(C, t) * MIF(S, C, t)}{\sum_{c \in S} W(c, t) * MIF(S, c, t)}$$

Computation types

- ☐ Birnbaum (MIF)
- ☐ Critical (CIF)
- ☐ Fussell-Vesely (DIF)
- ☐ Manual selection of MIF algorithm
- ☐ Risk Achievement Worth (RAW)
- ☐ Risk Reduction Worth (RRW)
- ☒ Barlow Proschan (BP)

Partial derivative



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CHI2 BASED UNCERTAINTY

- “Observation” uncertainty with k freedom degree
- Probability density

$$f_x(T) = \frac{1}{2^{\frac{k}{2}} \Gamma(\frac{k}{2})} t^{\frac{k}{2}-1} e^{-\frac{T}{2}}$$

Degree of freedom used for “Observation” uncertainty is 2 * N + Degree of freedom used for “Observation” uncertainty when 0 observation,

- Distribution function
 - With precomputed tables



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BETA AND GAMMA UNCERTAINTY

- Gamma uncertainty

$$f(x) = x^{k-1} \frac{e^{-x/\theta}}{\theta^k \Gamma(k)}$$

- Beta uncertainty

$$f(x; \alpha, \beta) = \frac{1}{B(\alpha, \beta)} x^{\alpha-1} (1-x)^{\beta-1}$$

Avec

$$B(x, y) = \int_0^1 t^{x-1} (1-t)^{y-1} dt$$



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UNITS IN LAW PARAMETERS

● Units displayed by default

Properties of 'Events' - Evt1

Number1

Name (☒ Automatic)Evt1

Description

GeneralAttributesAdvanced...

LawTPS / Simple periodic test

This law allows a component which fails to be represented according to an exponential distribution law and whose failure is found during a periodic te ...

Parameter(s)

Lambda (λ)1E-3h⁻¹

Tau (τ)7.2E1h

T00h

TypeUndeveloped / Elementary event

OKCancelHelp

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UNITS IN LAW PARAMETERS

● Unit modification activation

GRIF - Fault Tree Module

LayersEventsGates/ShortcutsCanvas

Options

Apply modification factor on laws

Unit choice for law parameters.

Activate unit selection for each parameter in law

Properties of 'Events' - Evt1

Number1

Name (☒ Automatic)Evt1

Description

GeneralAttributesAdvanced...

LawTPS / Simple periodic test

This law allows a component which fails to be represented according to an exponential distribution law and whose failure is found during a periodic te ...

Parameter(s)

Lambda (λ)500FIT

Tau (τ)3Y

T00Y

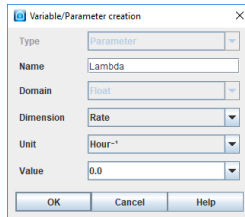
TypeUndeveloped / Elementary event

OKCancelHelp

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UNITS IN PARAMETERS

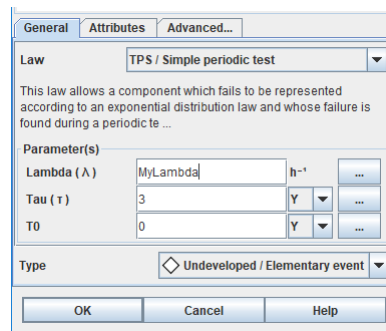
- If MyLambda is a parameter with unit



Variable/Parameter creation dialog box showing the following fields:

- Type: Parameter
- Name: Lambda
- Domain: Float
- Dimension: Rate
- Unit: Hour⁻¹
- Value: 0.0

Buttons: OK, Cancel, Help



General tab of the TPS / Simple periodic test dialog box showing the following fields:

- Law: TPS / Simple periodic test
- Description: This law allows a component which fails to be represented according to an exponential distribution law and whose failure is found during a periodic te ...
- Parameter(s):
 - Lambda (λ): MyLambda, h⁻¹
 - Tau (τ): 3, Y
 - T0: 0, Y
- Type: Undeveloped / Elementary event

Buttons: OK, Cancel, Help



BINOMIAL FAILURE RATE CCF

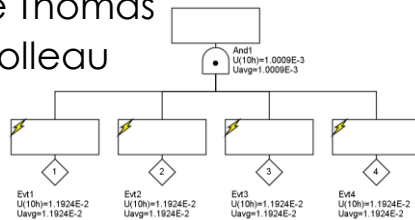
- Choc model defined by Atwood (1986):
 - Failure rate is made of
 - intrinsic failure rate
 - Lethal choc rate (w)
 - Non-lethal rate (μ) impacting a component (with a probability p)
- Nureg/CR-5485 (proba only, even if original definition with rates):
 - $Q = Q_{intrinsic} + p \cdot \mu + w$



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BINOMIAL FAILURE RATE CCF

- 3 developments proposed with :
 - Same probabilities
 - Different minimal cuts-set
- 3 proposals:
 - One “simple” NUREG approach
 - One by Philippe Thomas
 - One By Cyrille Folleau



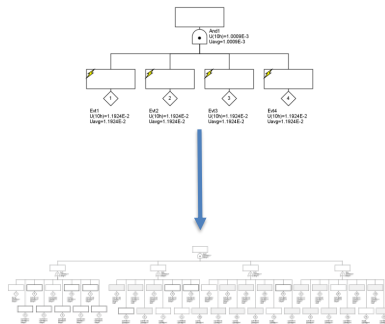
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BINOMIAL FAILURE RATE CCF

- NUREG's approach

- Ev1 := [Ev1#_ | CCF1#1000 | CCF1#1100 | CCF1#1010 | CCF1#1110 | CCF1#1001 | CCF1#1101 | CCF1#1011 | CCF1#1111 | CCF1#_];
- Ev2 := [Ev2#_ | CCF1#0100 | CCF1#1100 | CCF1#0110 | CCF1#1110 | CCF1#0101 | CCF1#1101 | CCF1#0111 | CCF1#1111 | CCF1#_];
- Ev3 := [Ev3#_ | CCF1#0010 | CCF1#1100 | CCF1#0110 | CCF1#1110 | CCF1#0011 | CCF1#1101 | CCF1#0111 | CCF1#1111 | CCF1#_];
- Ev4 := [Ev4#_ | CCF1#0001 | CCF1#1100 | CCF1#0101 | CCF1#1101 | CCF1#0011 | CCF1#1011 | CCF1#0111 | CCF1#1111 | CCF1#_];
- And1 /" root "f := [Ev1 & Ev2 & Ev3 & Ev4];
- attribute set is root And1 "true";
- law Ev1#_ exponential 0.001;
- law CCF1#1000 factor(0.0729, exponential 0.001);
- law Ev2#_ exponential 0.001;
- law CCF1#0100 factor(0.0729, exponential 0.001);
- law CCF1#1100 factor(0.008100000000000001, exponential 0.001);
- law Ev3#_ exponential 0.001;
- law CCF1#0010 factor(0.0729, exponential 0.001);
- law CCF1#1010 factor(0.008100000000000001, exponential 0.001);
- law CCF1#0110 factor(0.008100000000000001, exponential 0.001);
- law CCF1#1110 factor(9.000000000000002E-4, exponential 0.001);
- law Ev4#_ exponential 0.001;
- law CCF1#0001 factor(0.0729, exponential 0.001);
- law CCF1#1001 factor(0.008100000000000001, exponential 0.001);
- law CCF1#0101 factor(0.008100000000000001, exponential 0.001);
- law CCF1#1101 factor(9.000000000000002E-4, exponential 0.001);
- law CCF1#0011 factor(0.008100000000000001, exponential 0.001);
- law CCF1#1011 factor(9.000000000000002E-4, exponential 0.001);
- law CCF1#0111 factor(9.000000000000002E-4, exponential 0.001);
- law CCF1#1111 factor(1.0000000000000002E-4, exponential 0.001);
- law CCF1#_ exponential 1.0E-4;



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ICONS FOR OPTIONS

The 'Options' dialog box for 'GRIF - Module Booléen' contains the following sections:

- Configuration de la police**: Font settings for the main interface.
- Configuration de la police du commentaire**: Font settings for comments.
- Configuration du tracé**: Drawing configuration options.
- Afficher le nom**: ☒ dans la vue principale, ☒ dans les info-bulles
- Afficher la description**: ☒ dans la vue principale, ☒ dans les info-bulles
- Afficher les attributs**: ☐ dans la vue principale, ☒ dans les info-bulles
- Affichage de l'allocation (+%)**: ☐ dans la vue principale, ☐ dans les info-bulles
- Affichage de l'objectif**: ☐ dans la vue principale, ☐ dans les info-bulles
- Afficher la loi**: ☐ dans la vue principale, ☒ dans les info-bulles
- Afficher la DCC**: ☐ dans la vue principale, ☒ dans les info-bulles
- Utiliser une loi par défaut**: ☒
- Loi par défaut**: exponential 0.001
- Informations supplémentaires**:

	U(tast)
	Uavg
- Épaisseur du rectangle des références**: 2
- Transparence des événements répétés**: 0.2
- Hauteur du commentaire**: 40
- Largeur du commentaire**: 100

Buttons: OK, Annuler, Aide

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ONLY NECESSARY TABS

The main interface shows a fault tree diagram with the following structure:

- Top event: Avt1
- Sub-events: Evt1, Evt2

The 'Evénements' tab in the 'Options' dialog shows the following table:

Num	Nom	Description	Page	Remois	Ots	Résultats
1	Avt1					

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THE END 😊



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