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	CLIENT:		SHEET 1 of 26
	JOB:		--
	AREA:		
SRGE	TITLE: CRITERIA FOR DETAILING DESIGN CAUSE & EFFECT MATRIX		INTERNAL
			ESUP

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1 INTRODUCTION

1.1 Object

1.1.1 This Technical Specification describes the criteria that shall be adopted for filling out the Cause & Effect Matrixes (CEMs) for the UNIT's SAFETY SYSTEMS during the Detailing Design phase of the project.

1.1.2 The CEM shall be filled out according to logic diagrams, P&IDs, Safety Datasheet, Safety Philosophy and any other project documentation that specifies how and when actions are to be executed in a SAFETY SYSTEM.

1.1.3 Any discrepancy between project documents or ambiguous logic definition required for filling out the CEM shall be reported to PETROBRAS.

1.1.4 The spreadsheet file template is presented in item 8., which not only has the template to be used but also shows examples of tricky representations.

1.2 Definitions

1.2.1 Refer to I-ET-3010.00-1200-940-P4X-002 – GENERAL TECHNICAL TERMS.

1.3 Abbreviations, Acronyms and Initialisms

AFDS	Addressable Fire Detection System
CEM	Cause and Effect Matrix
CSS	Control and Safety System
D&ID	Ducting and Instrumentation Diagram
ESD	Emergency Shutdown
FGS	Fire and Gas System
HFGS	Hull Fire and Gas System
HSD	Hull Shutdown System
PA/GA	Public Address / General Alarm
P&ID	Piping and Instrumentation Diagram
PLC	Programmable Logic Controller
PSD	Process Shutdown System

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2 REFERENCE DOCUMENTS, CODES AND STANDARDS

2.1 Internal References

2.1.1 Project Documents

I-ET-3010.00-1200-800-P4X-002	AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS
I-ET-3000.00-1200-940-P4X-001	TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN

3 CRITERIA FOR CAUSE AND EFFECT MATRIXES OF SAFETY SYSTEMS

3.1 Cause and Effect Matrices issued by each contract

3.1.1 Each contract shall contain only 1 (one) matrix file for each of the UNIT's SAFETY SYSTEMS. All logic will be represented in these matrixes and shall be stratified in "SYSTEMS" for shutdown systems (as described in project's list of commissioning items), and "FIRE ZONES" for FGS/HFGS. The stratification shall be done so that causes pertaining to different SYSTEMS and/or FIRE ZONES shall not be listed on the same tab (unless it is an interface sheet as will be explained later on).

3.1.2 The title of each matrix is composed of "CAUSE AND EFFECT MATRIX" followed by the system abbreviation/ initialism, e. g., FGS.

3.1.3 FGS/HFGS CEM shall have at least one sheet for each of the ESD levels: ESD-4, ESD-3P and ESD-3T, initiating right after interface sheets.

3.1.4 PSD/HSD CEM shall have at least one sheet for ESD-2 level right after interface sheets.

3.1.5 The CEM documents cannot be understood as separate documents but instead as a set of documents constituting a collection.

3.1.6 It must be planned how CEM documents interface with each other. This is to define how conditions for ESD levels will be exchanged between documents. The logic for ESD levels shall reflect the distribution of CSS automation subsystems. This ESD generation shall be planned before the emission of any CEM and shall be included as a note in the FGS CEM and remaining CEMs

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shall refer this note. See Figure 3-I for an example of ESD generation in a set of CEM documents, being CEM documents for: HSD, PSD, FGS and HFGS.

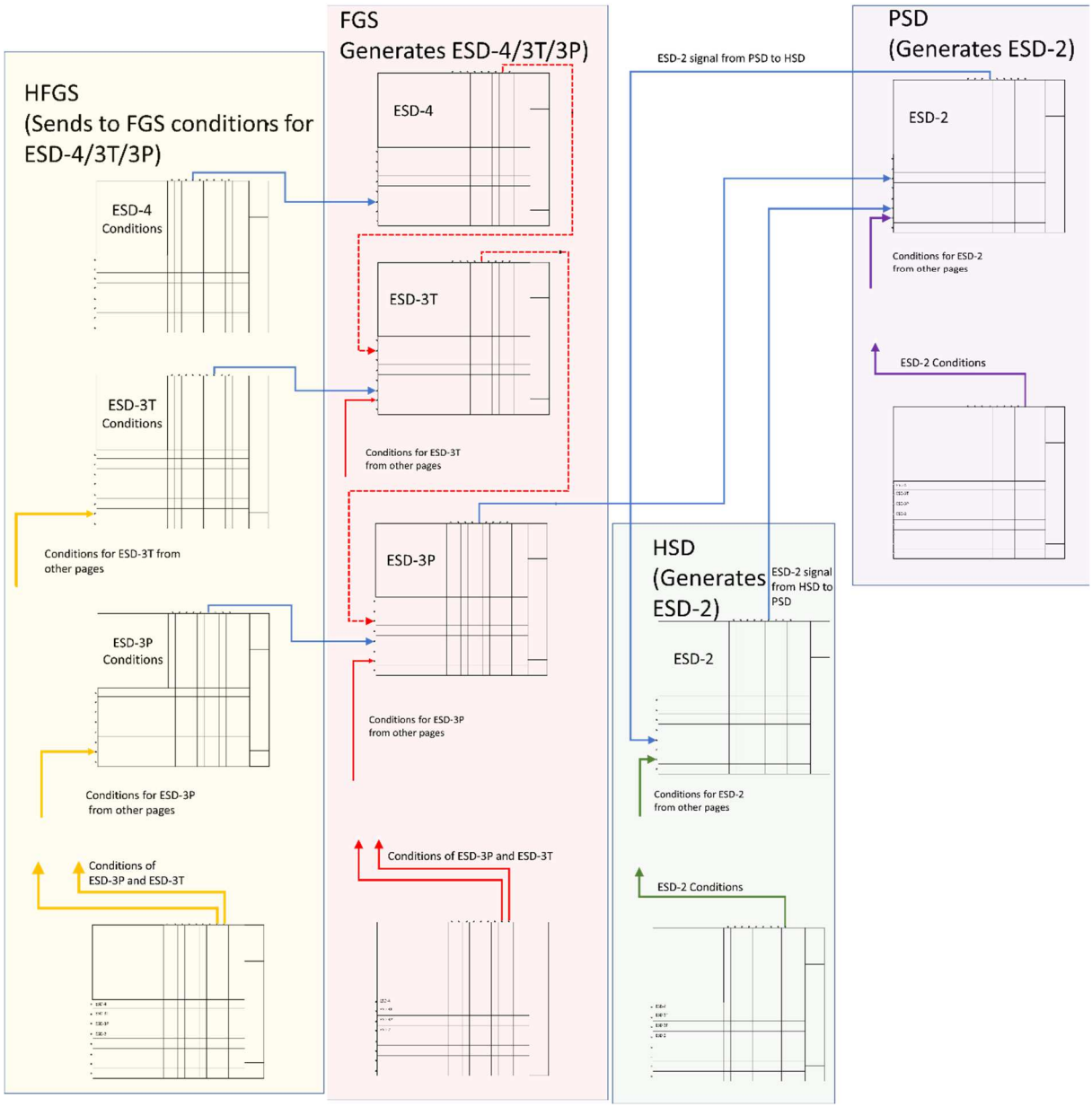

Figure 3-I – Example of a diagram of signals exchange for ESD levels generation.

3.2 Distribution of pages

3.2.1 Each tab of the spreadsheet file corresponds to a specific page of the final PDF document. The tabs shall be named “PG_001”, “PG_002”, …, “PG_100”. More pages may be added if needed.

3.2.2 In the spreadsheet of any matrix document, the first sheet shall be the “Cover Page”, the second and third sheets, the “Index”, and sheets four through fifteen shall be reserved for “General Notes”, elucidation and future provision of logic,

interface, or any other information that might be needed. For the last items, PETROBRAS shall be explicitly consulted.

3.2.3 On the main matrix files, starting at the 16th sheet, two sheets shall be reserved per Contract for interface treatments. The even sheets are destined for signals received from other Contracts while the odd sheets are destined for signals sent to other Contracts.

3.2.4 In Contract matrixes (not on the main matrix), the sheet that receives signals from the main matrix is always the 16th sheet and the sheet that sends signals to the main matrix is always the 17th sheet.

3.2.5 The main PSD matrix concentrates the interfaces with all Contract's PSD matrixes. The main HSD matrix concentrates the interfaces with all Contract's HSD matrixes. The main FGS matrix concentrates the interfaces with all Contract's F&G matrixes. The main HFGS matrix concentrates the interfaces with all Contract's F&G matrixes. If a signal from one Contract is needed in another Contract, it shall be sent to the main matrix so that it could be distributed among the other Contracts.

3.2.6 Signals can only be exchanged directly (without being sent to the main matrix for routing) between PSD, HSD, F&G and HF&G matrixes in the same Contract if, and only if, these signals are not necessary in any other Contract.

3.2.7 Pages corresponding to unused sheets shall not be removed and shall have a "RESERVED SHEET" watermark. The document shall not have hidden sheets.

3.3 Meaning of each "CAUSE" field

3.3.1 The "CAUSE" field comprises 7 (seven) subfields, namely: "V", "REF DOC", INTERFACE, "DESCRIPTION", "VOTING", "TAG NUMBER", and "DELAY".

3.3.2 The "VIRTUAL FUNCTION" or "V" subfield indicates whether the binary signal that serves as input to the CEM is a discrete signal coming from a physical I/O card on the CSS (directly or derived from an analogic signal), from an external system sent through network, a signal from SOS or an interface signal. The "V" field has 5(five) possible values: "P", "T", "E", "S" and "I" that represent each of these cases, respectively:

PHYSICAL (P) - When the field is filled out with the letter "P", it means that the cause is a *binary physical signal,* i.e. a digital input signal from a CSS I/O card. This symbol can only be used once for each instrument. If it is needed on another sheet of the matrix, the signal shall be routed by creating an *interface signal* "I".

TRANSMITTER (T) - If the "T" symbol is used, it indicates that the cause comes from an *analogic physical signal* generated by an instrument with a 4-20 mA transmitter, i.e. an analogic input signal from a CSS I/O card. The signal is then

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logically compared to threshold generating a binary value that will serve as input to the CEM. This symbol can only be used once for each instrument. If it is needed on another sheet of the matrix, the signal shall be routed by creating an *interface signal* "I".

EXTERNAL (E) - The "E" symbol means that the signal reaches the CSS by means of network communication instead of a discrete or analogic I/O card. This is the case with signals coming from external systems such as the AFDS. This symbol can only be used once for each instrument. If it is needed on another sheet of the matrix, the signal shall be routed by creating an *interface signal* "I".

SUPERVISORY (S) – When a signal is related to S.O.S. HMIs as, for example, virtual push buttons used to define operational modes to pump start or alarm indication.

INTERFACE (I) – The aforementioned symbols may only be used once for each signal. If a signal is necessary on another sheet, an interface signal shall be created and the "I" symbol shall be used. The "I" symbol indicates that a signal is exchanged between sheets of the same matrix.

For instance, consider a signal generated by a specific instrument on page 40, row 35 and that the "V" field on this row is already filled out with the "P", "T" or "E" symbols. Consider also that this signal is needed on page 52, row 21. In this case, the following procedure shall be followed for *generating an interface signal* and adequately routing the original signal:

- The INTERFACE field under EFFECTS on a free column of page 40 shall be filled out with "P.052 R.21". Assume this column to be 15.
- An "X" shall be marked on the intersection between row 35 and column 15, on page 40.
- The INTERFACE field under CAUSE on row 21 of page 52 shall be filled out with "P.040 C.15", indicating that the virtual signal comes from page 040, column 15.
- The "V" field under CAUSE shall be marked with the "I" symbol on line 21 of page 52 indicating that it is an interface signal.

3.3.3 "REF DOC" field: In this field, a reference document is written, such as the identification code of the P&ID where the logic is represented. When the signal comes from another CEM, this field shall be filled with the identification code of the document of the other matrix so that this number, along with the INTERFACE field indicates the origin of the signal.

3.3.4 "INTERFACE" field: This field indicates the origin. The format of this field is P.XXX C.EE, where P means the page and C the column. If the signal is received from a page of the same CEM document the INTERFACE field shall be filled between brackets as [P.XXX C.EE]. When the INTERFACE comes

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from another document, the INTERFACE is not written between brackets and the REF DOC field must be filled with the number of the CEM where the interface originates.

3.3.5 "DESCRIPTION" field: Succinct signal description, including either, the protected equipment, the process service or fire and gas zone.

3.3.6 "VOTING" field: When a group of signals is responsible for the same cause, this field indicates the voting scheme (i.e. 1ooN, 2ooN). See item 5 for more details on the representation of voting schemes.

3.3.7 "TAG NUMBER" field: Indicates the TAG of the signal. When it is a physical signal (denoted by a "P" letter in the "V" field) the TAG NUMBER shall be equal to the TAG of the discrete input of the CSS I/O corresponding to this signal, (i.e. the TAG shall be the same as presented on the I/O List). If TAG is a virtual discrete signal derived from a transmitter, the field "V" is filled with "T". Example, PSLL-1231002 derived from PIT-1231002. In both cases, a TAG when "V" field is equal do "P" or "T", it can only be used once and if needed in another page it shall be sent as an interface using a column (see PHYSICAL and TRANSMITTER in item 3.3.2).

3.3.8 "DELAY" field: Used to indicate the time value internally used on the PLC programming code to generate a cause. For example, the time that a very high level shall continue to be equal to or greater than the threshold in order to generate the LSHH signal. The default time unit to be used is seconds (s). PETROBRAS shall be consulted if another unit is intended to be used.

3.4 Meaning of each "EFFECT" field

3.4.1 The "EFFECT" field comprises 9 (nine) other fields, namely: "DELAY", "TAG NUMBER", "ACTION", "DESCRIPTION", "V", "REF DOC", "INTERFACE", "NOTES" and "SYSTEM" (SYS.).

3.4.2 "DELAY" - Used to indicate delay in logical generation of the effect in a specific column. It can also be used to indicate relative delays between effects, as is the case with the actuation of valves in Christmas trees of satellite production wells controlled by solenoid racks, as exemplified in Table 3.4-I.

Table 3.4-I – Example of time delay.

DELAY	TAG NUMBER	ACTION	DESCRIPTION
T0	SOLENOID TAG	CLOSE	PRODUCTION WING
T0	SOLENOID TAG	CLOSE	LIFT GAS WING
T1=T0+60s	SOLENOID TAG	CLOSE	PRODUCTION MASTER
T1=T0+60s	T SOLENOID TAG	CLOSE	LIFT GAS MASTER
T1=T0+60s	SOLENOID TAG	CLOSE	DHSV

3.4.3 "TAG NUMBER" - Indicates the signal TAG. When it is a physical signal, indicated by "P" letter in "V" field, the TAG NUMBER shall be the TAG of the discrete output of CSS referent to this signal. This TAG together with field ACTION meaning a distinct effect can be used only once, when "V" field is filled

with “P”. The use of “P” symbol indicates the end of a logic and an actuation of a SDV, for example. Therefore, all TAGs with “V” field filled with “P” shall correspond the same TAG in I/O List.

3.4.4 “ACTION” - Describes the action that the logic executes. Possible values are:

START: To indicate the load is trigged (e.g. turning on a pump),
STOP: To indicate the load is off (e.g. stopping a pump),
TRIP: To indicate the load is off due to the occurrence of an emergency (e.g. if there is a high pressure in pump discharge, the pump shall suffer an emergence shutdown by trip),
CLOSE: Indicates, for example, the closure of an SDV,
OPEN: Indicates, for example, a BDV valve opening,
INITIATE: Used to identify signals which generate ESD levels.

3.4.5 “DESCRIPTION” field - Succinct description of the action.

3.4.6 The “V” field has 4 (four) possible values: “S”, “P”, “I” and “E”. The letter “S” means an effect that is shown only on S.O.S. HMI. “P” means that it is a physical signal, discrete output signal from CSS and the TAG to be used is on I/O List. When “I” symbol is used means the logic for an action is not completed yet and this logic shall be sent as a cause for another logic. The fields “REF DOC” and “INTERFACE” indicates where the signal is sent to. The “E” symbol is used to indicate that a signal is sent by network to another system.

3.4.7 “REF DOC” field - Used for referring another document, such as a P&ID, or, when used along with the INTERFACE field, for indicating where the logic result of a column is sent to.

3.4.8 “INTERFACE” field - Expresses the page and the line to which the signal is sent to. When the interface is with another matrix, this field, together with “REF DOC” field, composes the signal destiny. The field format is P.XXX R.LL, where “P” means page and “R” the row. When interface is within the document itself, the INTERFACE field shall be filled between brackets as follows: [P.XXX R.LL]. The logic of a column can be sent to more than one page. In general, the filling method of this field considering all possibilities would be:

REF DOC field: Number
INTERFACE field: [P.XXX R.LL/P.YYY R.MM/P.WWW R.NN] or P.XXX R.LL/P.YYY R.MM/P.WWW R.NN, when row numbers are different;

INTERFACE field: [P.XXX, YYY, WWW R.LL] or P.XXX, YYY, WWW R.LL, when in all pages the row number is the same and pages are not in sequence;

INTERFACE field: [P.XXX-WWW R.LL] or P.XXX-WWW R.LL, when in all pages the row number is the same and pages are in sequence;

NOTE: a note shall be included with the “INTERFACE” field, to detail the interface and make it easier to read.

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Where:

i) XXX, YYY, WWW are pages from the matrix itself, indicating internal interfaces, where REF DOC field is not used;

ii) LL, MM and NN are the row numbers for signal destiny;

iii) When separating page or row numbers by comma, there shall always be a space between the comma and the number.

3.4.9 "NOTES" field - To indicate the note number where the explaining text is in "GENERAL NOTES" field.

3.4.10 SYSTEM (SYS.) – shall be to organize the CEM, indicating the system that the logic belongs to.

3.5 General filling rules

3.5.1 Signals, instruments and equipment listed on the CEM shall be tagged according to I-ET-3000.00-1200-940-P4X-001 – TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN.

3.5.2 The interface sheets between matrixes of multiple Contracts shall not contain logic, i. e., combination of multiple signals by means of ORs or ANDs. These sheets are only for signal "routing".

3.5.3 The interfaces with packages CEM are to be done exclusively through the interface signals, not through INTERFACE and REF DOC fields. In CSS a logic either reads or activates signals and each system is designed and tested using the respective TAGs. If fields INTERFACE and REF DOC are used it opens the chance for inconsistencies between documents of different parties. In these interfaces the TAG is the information that shall be used in both documents, CSS CEM and package CEM.

3.5.4 As per item 3.1.6 for, the elected CEMs shall implement the logics for ESD-2, ESD-3P, ESD-3T and ESD-4 levels. Therefore, in order for the elected CEMs to be able to generate all ESD levels, all other matrixes shall send the conditions that create each ESD state. The detected conditions shall be indicated in description field, not the ESD state. Once defined, the ESD level is to be used where demanded but it is not to be indicated its origin in the INTERFACE field since ESD levels are well defined states of the unit. See item 3.5.5 for where ESD levels shall be located in every page.

3.5.5 In all pages the 4 first rows shall be reserved for ESD levels, being first row for ESD-4, second row for ESD-3T, third row for ESD-3P and fourth row for ESD-2. If the ESD level is not used in a page, the row shall not be used for any other

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mean, being kept empty. This way ESD levels can always be found in the same row of every page.

3.5.6 The conditions for each ESD level sent from every page to the pages that represent the logic of ESD levels shall always use the last columns for this purpose. If in a page there is no ESD condition to be sent the column shall be kept empty.

3.5.6.1 In FGS and HFGS matrixes the column 49 shall be used for ESD-3P conditions and column 50 for ESD-3T conditions.

3.5.6.2 In PSD and HSD matrixes the column 50 shall always be used for ESD-2 conditions.

3.5.7 All signals used in the CEM, both as cause or effect, shall correspond to a signal on the project's I/O List. Similarly, all signals on the I/O List that have a safety interlocking function shall be used on CEM.

3.5.8 The actuation of a logic is the actuation of an I/O signal from the CSS. This actuation shall exist only once, and it shall be identified by the use of the "P" symbol in the "V" field under EFFECT and the corresponding TAG in column's "TAG NUMBER" field. Therefore, it is incorrect to use the same TAG more than once to represent the same action.

3.5.9 Each Contract is responsible for its own I/O signals. If a signal from another package is needed to fill out the CEM, it shall be made using interface sheets. There may be exceptions to this rule, but those shall be discussed with PETROBRAS beforehand.

3.5.10 When necessary, actions are executed by interlocking and control systems of Packages, these actions are initiated by discrete physical signals exchanged between the CSS and the Package's panel. Therefore, this action shall be represented on the CEM using the physical signal that generates the emergency stop on the Package. The actions which occur inside the Package, such as the closure of two SDV, a reference document from Contract where actions are defined shall be indicated on notes. For such actions, the "TAG NUMBER" field shall be filled out with the corresponding TAG on the I/O List and the "V" field shall be filled out with the "P" symbol.

3.5.11 Logic executed by interlocking and control panels of PACKAGED UNITS (except P0 packages, according to I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS)

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shall not be represented in the CEM of the CSS in order to avoid duplicated information.

3.5.12 The logics shall be represented informing the origin and destination of a signal using the INTERFACE and REF DOC. fields. There are a few exceptions, which are all listed below:

3.5.12.1 PA/GA: The second column of a sheet with logic is reserved to indicate when PA/GA is activated. It shall not be done interfaces from all pages to a single page to make an OR with all causes. Even though not represented, the PA/GA activation, both PA/GA A and PA/GA B, is defined as an OR with all single activations from every page. To represent this immense OR is cumbersome, polluting the document.

3.5.12.2 CCR ALARM: The same principle of PA/GA above is applicable. The CCR Alarm shall always be represented in the first column of a sheet with logic and the actual CCR Alarm logic is the OR of all columns in every page. To represent this immense OR is cumbersome and pollutes the document.

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4 DEFINITION OF LOGIC FUNCTIONS

4.1 The logic on each column is based on an OR of a series of causes and defined functions. This OR is defined as “Effect OR”. See below a simplified representation of how is defined the logic of each column:

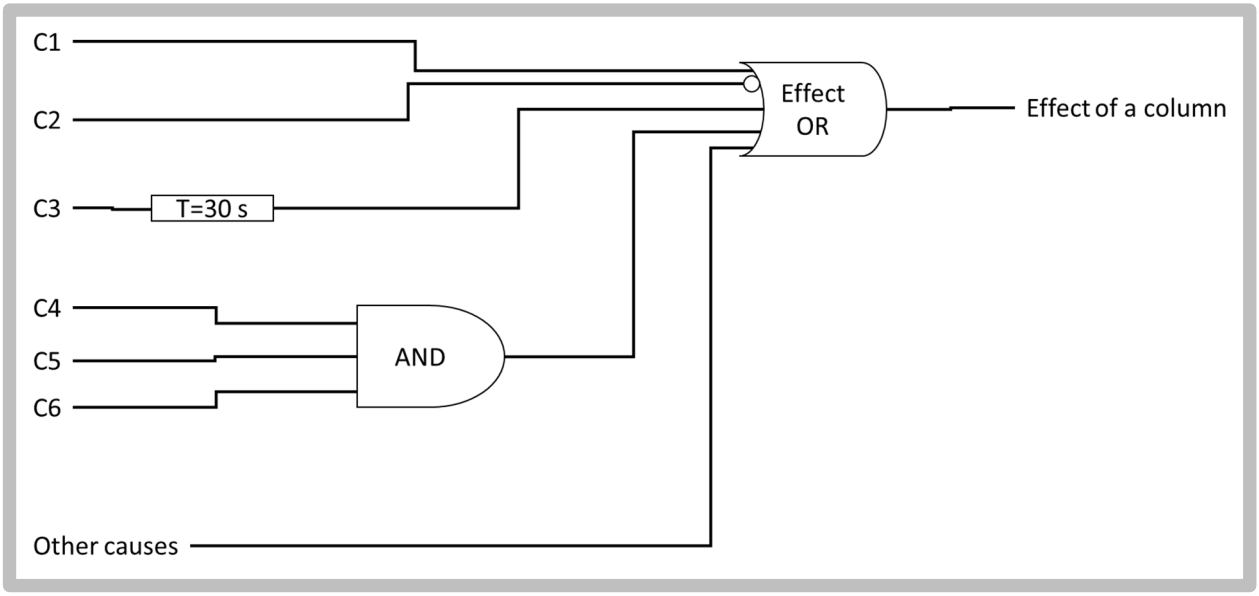


Figure 4-I - Example of how the logic in each column is understood.

4.2 The symbols “X”, “T”, “N”, “A”, “An”, “NA” and “NAn” where n is an index are used on the CEM to represent logic as an OR of MINTERMS. The following is an example of a Boolean expression using MINTERMS, with each cause represented as Cm, where m is an index and “x” means AND and “+” means OR: C1 + NOT(C2) + C3xC4 + C4xC5 + C6xC7xC8.

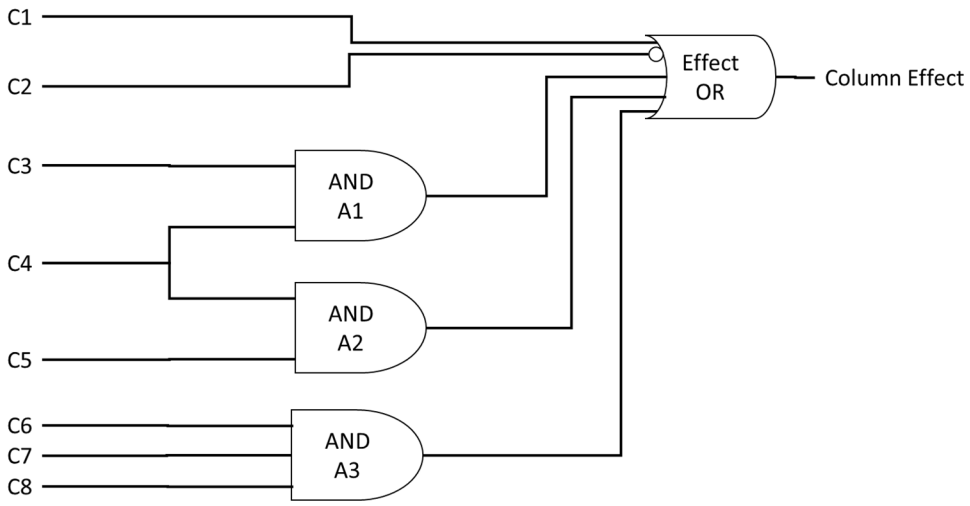


Figure 4-II - Example of logic how the logic in MINTERMS: C1 + NOT(C2) + C3xC4 + C4xC5 + C6xC7xC8.

4.3 The symbol “XAn”, “TXAn” and “NXAn” together with “An”, where n is an index, are to represent an OR where its result is an input of an AND (An) and the output of this An is an input of the “Effect OR”. See picture below for an example.

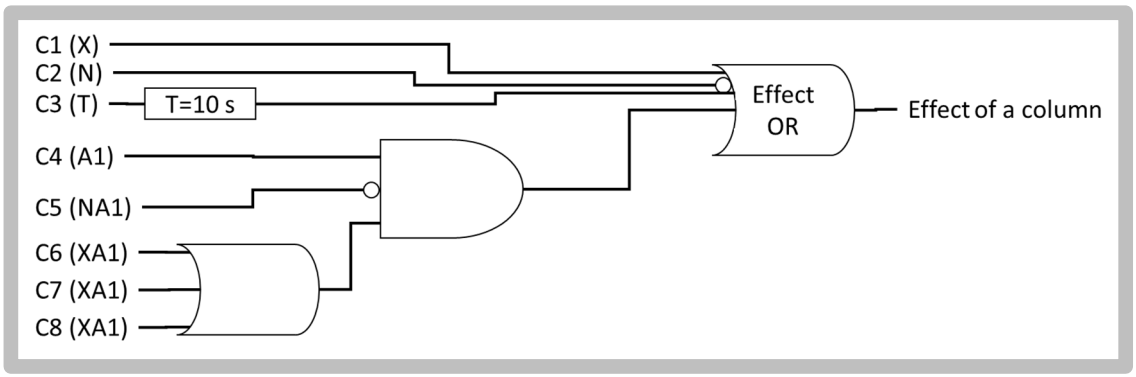


Figure 4-III - Example of logic using symbols “XAn” and “XNAn”.

4.4 The symbol “Dn” is to be used only on page to represent the sequence of BDV openings during a depressurization. Refer to item 6.2 for a more detailed explanation and examples.

4.5 The symbol "E” is to be used only once in each column. It shall always be located in the rows just after the ESD levels. Its function is an enabler of all the logic in the column, e.g, when the CAUSE is FALSE the logic is not enabled and the effect is always FALSE. Similarly, the symbol “NE” is used to indicate that when a CAUSE is true the logic is not enabled. These symbols require previous approval to be used since are not to be used without previous analysis. An example of its use is for wells that can work as multiplexed or Direct Hydraulic Controlled. See on figure below the meaning of this symbol in a logic of a column.

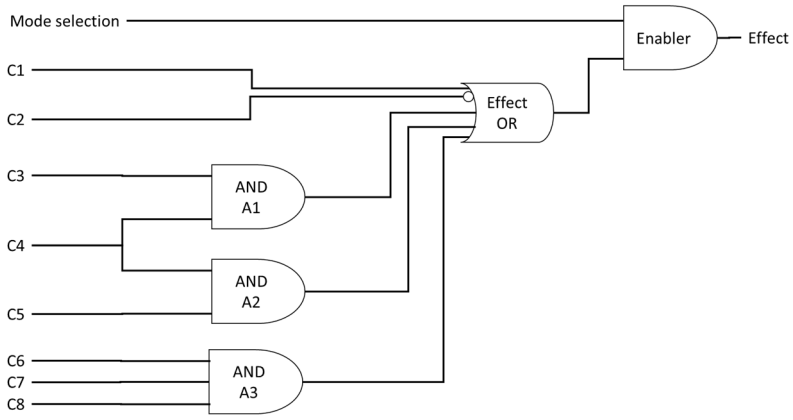


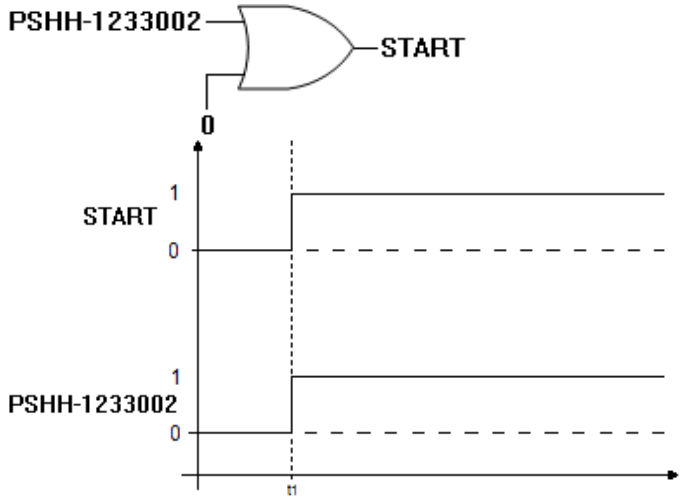
Figure 4-IV – Example of the Enabler function.

4.6 Below are some examples. The figures shown below are just logic implementation examples. In the Cause and Effect Matrix document, the two first columns shall be reserved for alarm indication.

4.6.1 The “X” symbol on a specific row means that the signal listed on that row is an input to a logic “OR”. The action on the column represents the resulting signal of the logic operation. If only one row of a certain column contains an “X”, the other input is a logic “0”.

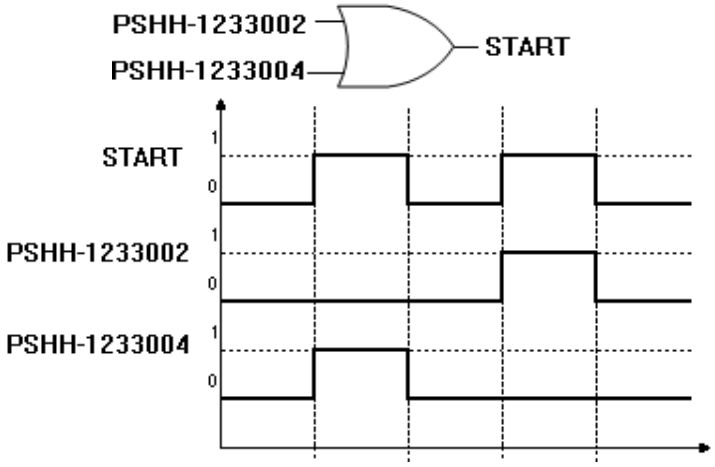
Example 1:

TAG NUMBER	DELAY	ACTION / TAG NUMBER / DELAY	01	02	03	04	05
		01					
		02					
		03					
		04					
		05					
PSHH-1233001		06					
PSHH-1233002		07				X	
PSHH-1233003		08					
PSHH-1233004		09					



Example 2:

TAG NUMBER	DELAY	ACTION / TAG NUMBER / DELAY	01	02	03	04
		01				
		02				
		03				
		04				
		05				
PSHH-1233001		06				
PSHH-1233002		07				X
PSHH-1233003		08				
PSHH-1233004		09				X

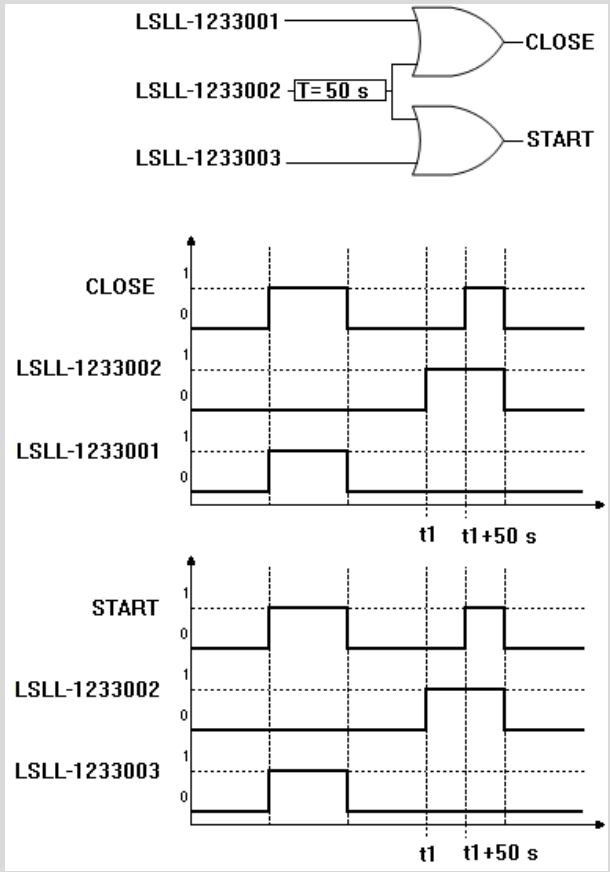


4.6.2 The “T” symbol represents a logic “OR” with a time delay. When this symbol is used, the DELAY subfield of either the CAUSE or the EFFECT fields shall be filled out. There is a slight difference between the cases where the DELAY is applied to the input signal (Example 3) and to the output signal (Example 4). The following examples are illustrative of this subtle difference. The “T” symbol used in the CEM shall not be applied to guarantee signal stabilization such as is usually done with signals generated by level transmitters. This “debounce” sort of delay shall be dealt with in the specific project document called Setpoint List.

Example 3

i) When the delay is applicable to all columns:

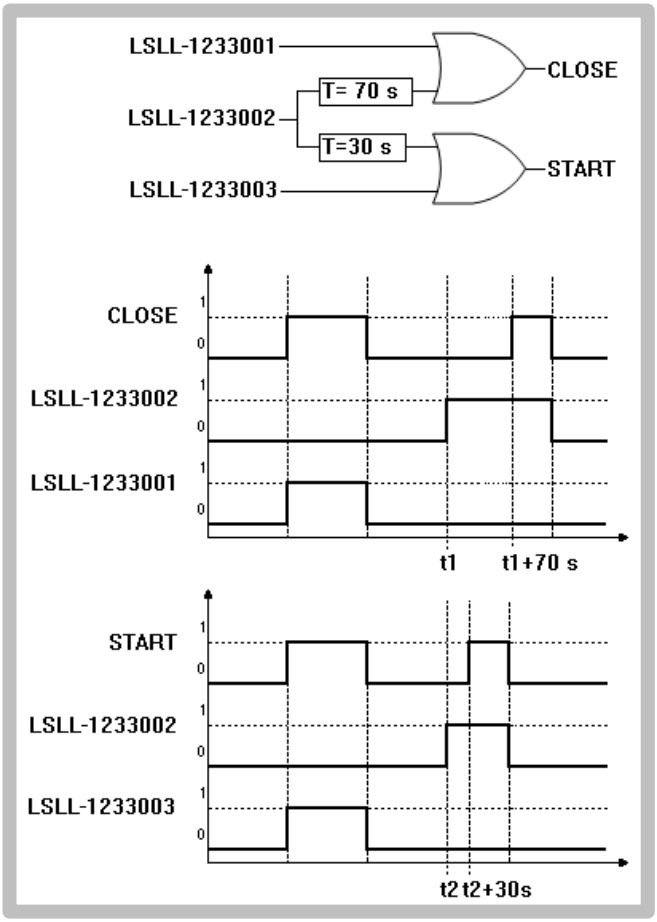
TAG NUMBER	DELAY	ACTION / TAG NUMBER	01	02	03
		01			
		02			
		03			
		04			
		05			
LSLL-1233001		06			
LSLL-1233002	50 s	07			
LSLL-1233003		08			
LSLL-1233004		09			



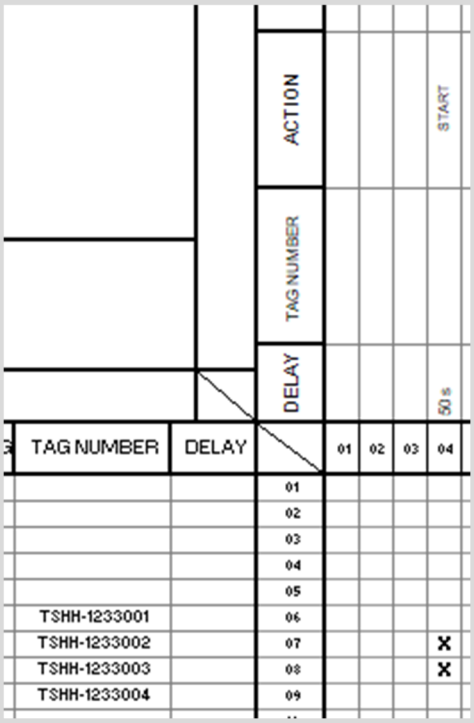
ii) When different delays are applicable

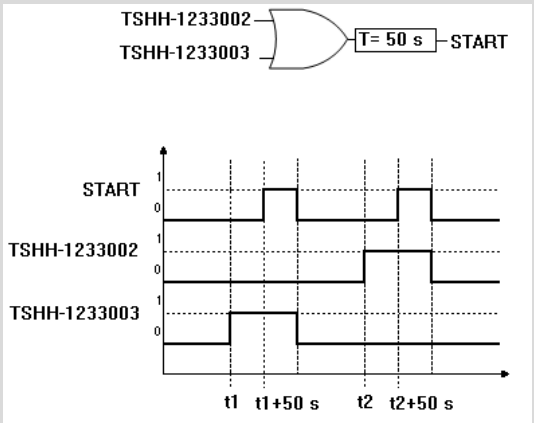
TAG NUMBER	DELAY	TAG NUMBER / DELAY	01	02	03	04	05	06	07	50	NOTES
		01									
		02									
		03									
		04									
		05									
LSLL-1233001		06						X			
LSLL-1233002	SEE NOTE	07				T		T			20
LSLL-1233003		08				X					
LSLL-1233004		09									

20- TIMER IN COLUMN 04 IS FOR 30 SECONDS AND IN COLUMN 06 IS FOR 70 SECONDS.


LSLL-1233001
T= 70 s
CLOSE
LSLL-1233002
T=30 s
START
LSLL-1233003
CLOSE
LSLL-1233002
LSLL-1233001
1
0
t1
t1+70 s
START
LSLL-1233002
LSLL-1233003
t2
t2+30s

Example 4:

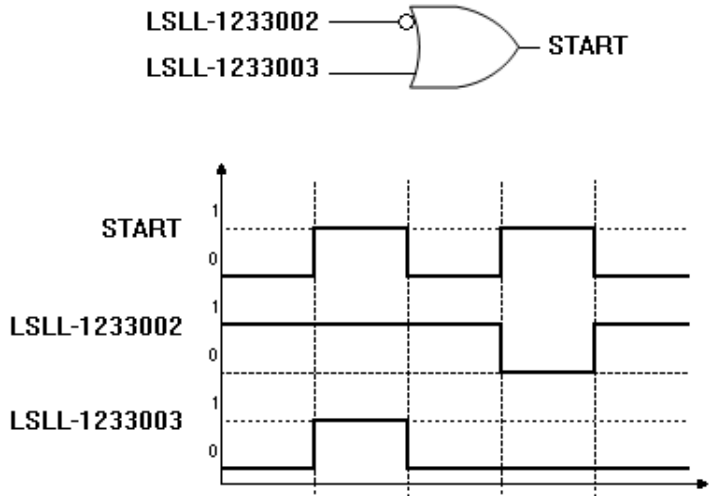

ACTION
START
TAG NUMBER
DELAY
50 s
TAG NUMBER
DELAY
01
02
03
04
TSHH-1233001
TSHH-1233002
TSHH-1233003
TSHH-1233004
06
07
08
09
X
X


TSHH-1233002
TSHH-1233003
T= 50 s
START
START
TSHH-1233002
TSHH-1233003
1
0
t1
t1+50 s
t2
t2+50 s

4.6.3 The “N” symbol represents an inverter input to a logic “OR”. The inversion is applied to the input signal, and not the output signal.

Example 5:

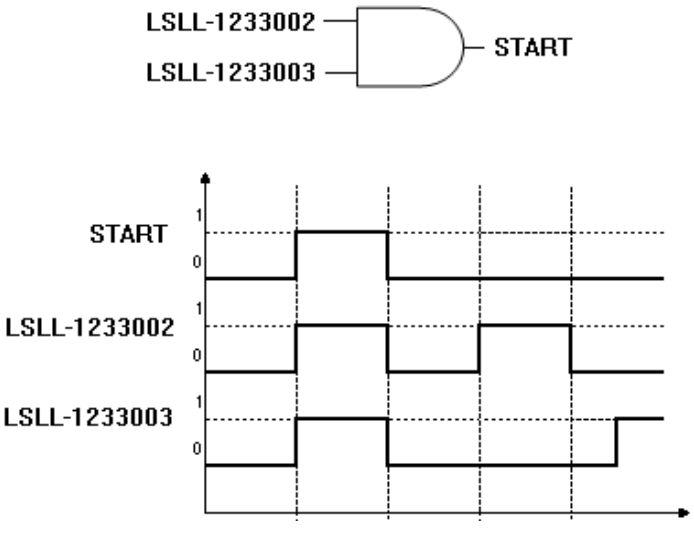
		ACTION				START
		TAG NUMBER				
		DELAY				
TAG NUMBER	DELAY		01	02	03	04
		01				
		02				
		03				
		04				
		05				
LSLL-1233001		06				
LSLL-1233002		07				N
LSLL-1233003		08				X
LSLL-1233004		09				



4.6.4 The “A” symbols represent a logic “AND”.

Example 6:

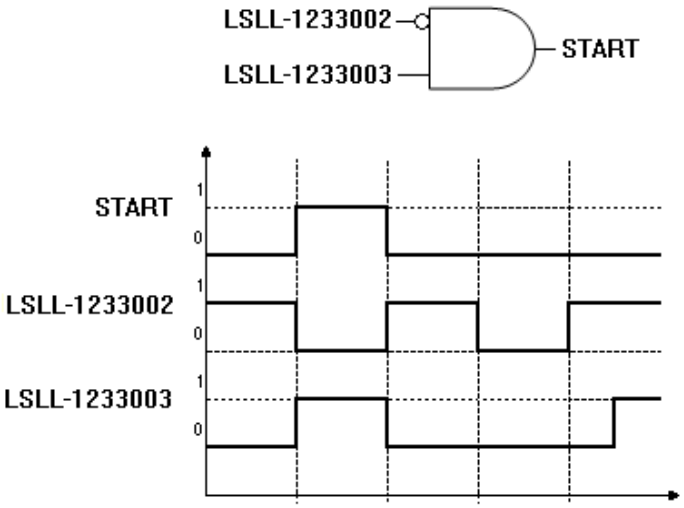
		ACTION				START
		TAG NUMBER				
		DELAY				
TAG NUMBER	DELAY		01	02	03	04
		01				
		02				
		03				
		04				
		05				
LSLL-1233001		06				
LSLL-1233002		07				A
LSLL-1233003		08				A
LSLL-1233004		09				



4.6.5 The “NA” symbol represents an inverted input to a logic “AND”. The inversion is applied to the input signal, and not the output signal.

Example 7:

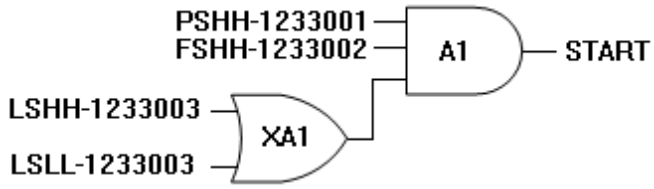
TAG NUMBER	DELAY	ACTION				START
		TAG NUMBER				
		DELAY				5 MIN
			01	02	03	04
		01				
		02				
		03				
		04				
		05				
LSLL-1233001		06				
LSLL-1233002		07				NA
LSLL-1233003		08				A
LSLL-1233004		09				



4.6.6 The “XAn” symbol represents an OR with 2 or more causes where the result is an input to an AND with symbol “An”.

Example 8:

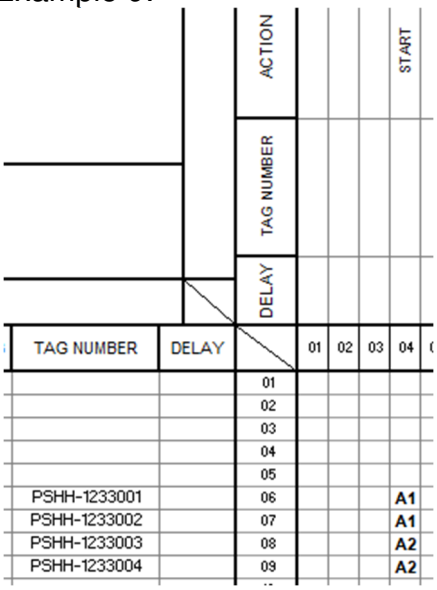
TAG NUMBER	DELAY	ACTION				START
		TAG NUMBER				
		DELAY				
			01	02	03	04
		01				
		02				
		03				
		04				
		05				
PSHH-1233001		06				A1
FSHH-1233002		07				A1
LSHH-1233003		08				XA1
LSLL-1233003		09				XA1

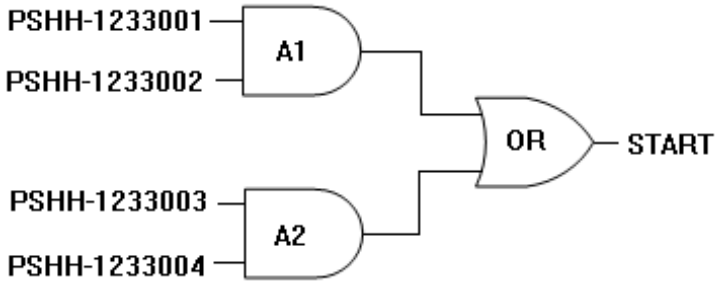


4.7 Representing complex logics

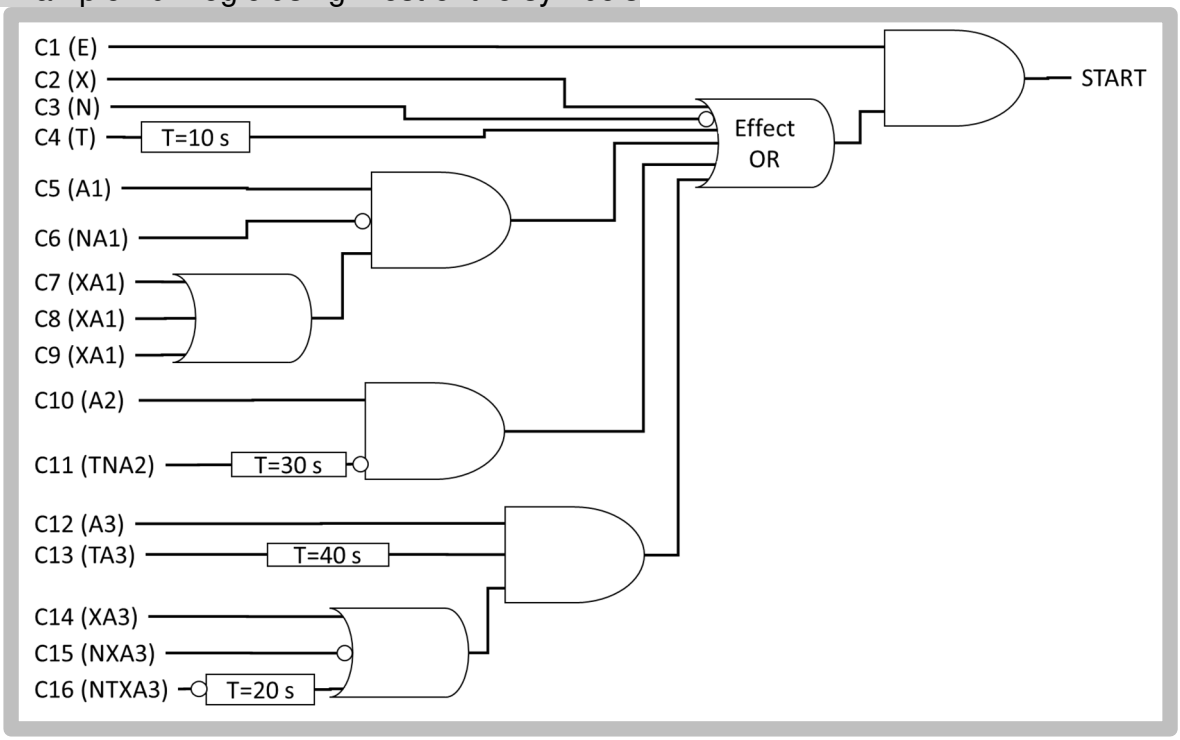
4.7.1 Multiple rows may contain symbols on the same column, indicating multiple inputs to a certain logic.

Example 9:





Example 10: Logic using most of the symbols



GRATOR

DESCRIPTION	VOTING	TAG NUMBER	DELAY	ACTION / TAG NUMBER / DELAY	01	02	03	START 04
				01				
				02				
				03				
				04				
HS_SELECTION (CAUSE 01)				05				E
CAUSE 02				06				X
CAUSE 03				07				N
CAUSE 04			10 s	08				T
CAUSE 05				09				A1
CAUSE 06				10				NA1
CAUSE 07				11				XA1
CAUSE 08				12				XA1
CAUSE 09				13				XA1
CAUSE 10				14				A2
CAUSE 11			30 s	15				TNA2
CAUSE 12				16				A3
CAUSE 13			40 s	17				TA3
CAUSE 14				18				XA3
CAUSE 15				19				NXA3
CAUSE 16			20 s	20				NTXA3

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5 REPRESENTATION OF VOTING LOGIC

5.1 When a group of signals is responsible for the same cause, the “VOTING” subfield listed under the “CAUSE” field indicates the voting scheme (i.e. 1ooN, 2ooN).

5.2 The signals that participate in the same voting scheme shall be listed on consecutive rows and shall be separated from other signals by a blank line. A border shall be placed around the group of signals as to emphasize that the group of instruments will be participating on the same voting scheme and that a single effect results from the group.

5.3 The “VOTING” field shall be filled out only on the first row. An “X” shall be placed on the intersection of the row of the first signal and the cause. The 2ooN indication shall be placed on the last row of the group.

5.4 “N” on the voting scheme shall be replaced by the number of sensors (e.g. if there are seven point gas detectors voting on a zone, the voting scheme is 1oo7H for detected gas and 1oo7HH for confirmed gas).

5.5 Table 5.5-I indicates sample voting schemes for different sensor groups. Limits may vary according to Safety Datasheet and shall be indicated under the NOTES subfield of the corresponding row of the sensor group. The detectors are not limited to those listed on the table.

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Table 5.5-I - SAMPLE VOTING SCHEMES FOR DIFFERENT SENSOR GROUPS

DETECTOR	TYPE	VOTING	LIMITS	SERVICE
FLAME	POINT	1ooNHH	-	DETECTED FIRE
		2ooNHH	-	CONFIRMED FIRE
CO2 GAS	POINT	1ooNH	3,900 ppm	DETECTED GAS IN ZONE
		2ooNHH	30,000 ppm	CONFIRMED GAS IN ZONE
H2S GAS	POINT	1ooNH	8 ppm	DETECTED GAS IN ZONE
		2ooNHH	20 ppm	CONFIRMED GAS IN ZONE
CH4 GAS	POINT	1ooNH	20% LEL	DETECTED GAS IN ZONE
		2ooNHH	60% LEL	CONFIRMED GAS IN ZONE
CH4 GAS	LINE OF SIGHT (LOS)	1ooNH	1 LELm	DETECTED GAS IN ZONE
		2ooNHH	2 LELm	CONFIRMED GAS IN ZONE

6 EXAMPLES OF KEY LOGICS TO BE FOLLOWED

6.1 SUBSEA Christmas tree actuation

It is done by making separate pages for trip of an individual well (ESD-1) and a page for ESD-3P, ESD-3T, if applicable, and ESD-4. See an example in the attached file of Annex 8, to the right of sheet “SUBSEA >>”.

6.2 Sequencing of BDV openings.

Similar do item 6.1, a page will contemplate all BDVs with respective physical TAGs, with P in V column field. The symbol Dx is used to indicate the order each BDV opens, where 0 is to be used to indicate the systems that always depressurize when stopped. i.e., always depressurize when it trips, is tripped or simply proceeds an operational stop. This page is to be read in a row, i.e., each depressurization scenario is defined by a row that must be read beginning in D0 and then D1, D2, D3 and so forth. This only defines the order. The time between BDVs openings is defined by a routine in CSS-FGS. See an example in the attached file of Annex 8, to the right of sheet “BDV Sequencing >>”.

6.3 Signal Interfaced with multiple effects

When a signal is exchanged between pages of the same document or between documents, it shall be sent only once. It shall not be implemented one (1) instance of the same signal for every effect as, for example, to replicate the signal in 5 columns and

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interface with 5 rows in the same page to close 5 different SDVs. In the Annex Standard it is shown a correct and an incorrect example. See an example in the attached file of Annex 8, to the right of sheet “Interface multiple effects>>”.

7 MATRIX UNIFICATION PROCESS

7.1 After completing the CEM tests during onshore commissioning, an “AS BUILT” version of the document contemplating all markups and necessary modifications shall be issued.

7.2 The unification of the CEM, that generates the main matrix, shall update all links, since matrixes from each system will change its page numbers once unified. Since all links will be updated, the interface pages will be eliminated in the unified matrix.

7.3 The unification process of CEM shall be completed onshore, so that the document is issued before the UNIT leaves the shipyard.

7.4 Once the unified CEM is issued, the eventual need to cancel individual matrixes shall be informed. Eventual changes that occur after unifying the matrixes shall also be carried out.

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8 ANNEX

Cause and Effect Matrix template (with examples).

Std_CEM_I-ET-3010.
00-1200-800-P4X-01

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