PRESSURE RELIEF SYSTEM AND SAFETY INSTRUMENTED SYSTEMS

COMMON WEAKNESSES IN FIELD IMPLEMENTATION

Pressure relief and safety instrumented systems are often the last line of defense before the occurrence of a catastrophic event. But common weaknesses in implementation prevent this these from achieving their intent.

DESIGN – Failing to account for common cause failures of similar components

In many cases, process equipment are protected from loss of containment due to overpressure by multiple PSVs that all must open to meet the capacity requirement for the worst case (design criteria case) for the relief system. However, the designers fail to provide any extra relief valves. Therefore, based on standard failure statistics there is a decreasing probability as N increases (for NooN design) of All PSVs opening during the limiting design case load (if this case occurs):

Configuration	PFD Calculation (for $\beta < 0.2$)
NooN	$N \times PFD_{1oo1} + \beta \times PFD_{1oo1}$
MooN	$\frac{\frac{N!}{(N-M+1)!\times(M-1)!}(2\,PFD_{1oo1})^{N-M+1}}{(N-M+2)} + \beta \times PFD_{1oo1}$

EXAMPLES

$PFD_{1oo1} = 0.01$

$\beta = 0.1$

M	N	PFD (MooN)
1	1	0.0100
1	2	0.0011
2	3	0.0014
1	3	0.0010
3	**3**	**0.0310**
3	5	0.0010
4	5	0.0023
5	**5**	**0.0510**
14	15	0.0150
15	**15**	**0.1510**

ITPM PLANNING – Failing to control common-cause human error (dependent human errors)

Failure to account for dependent human errors when planning of tests or checks or PM of similar components in a system consisting of multiple key devices.

Dependence	Same person?	Close in time?	Same visual frame?	Writing required?	Repeating failure
Zero	No	Yes/No	Yes/No	Yes/No	X
Zero	Yes	No *(+2 days)*	Yes/No	Yes/No	X
Low	Yes	Low *(+1 day)*	No	Yes	$(1 + 19X)/20$
Moderate	Yes	Moderate *(+4h)*	No	No	$(1 + 6X)/7$
High	Yes	Yes *(<2h)*	No	No	$(1 + X)/2$
Complete	Yes	Yes *(<2h)*	Yes	Yes/No	1

For Complete dependence, the Probability of repeating a mistake is 1 !

BASELINE ESTIMATION – Failing to account for errors during human interventions

Failure to account for the relative probability of human error for such simple tasks like re-opening the block valves on either side of a PSV or leaving the entire SIF in BYPASS or miscalibration of transmitters.

$$PFD_{SYS} = PFD_{PSV} + P_{HE}$$

(This term should not be ignored)

EXAMPLE

PFD_{Target}	0.01	
PFD_{PSV}	0.01	
P_{HE}	0.04	Probability of leaving at least one block valve closed *(without independent audit)*
PFD_{SYS}	0.05	$> PFD_{Target}$

$$PFD_{SYS} = PFD_{SE} + PFD_{LS} + PFD_{FE} + P_{HE}$$

(This term should not be ignored)

RESULTS OF THIRD PARTY INSPECTION OF CSO BLOCK VALVES FOR PSVs

			UPSTREAM						DOWNSTREAM					
Unit	Total PSVs	Sampled PSVs	# BVs	# BVs wrong	# CS on BVs	# CS Missing	% BV wrong	% CS Missing	#BVs	#BVs wrong	#CS on BVs	#CS Missing	% BV wrong	% CS Missing
A	534	363	238	0	237	1	0	0.4	154	0	153	1	0	0.7
B	65	49	35	0	35	0	0	0	22	0	22	0	0	0
C	276	211	43	0	40	3	0	7	154	0	7	0	0	0
D	548	267	132	0	89	43	0	32.6	62	0	31	31	0	50
TOTAL	1423	890	448	0	401	47	0	10	392	0	213	32	0	12.7

WILLIAM BRIDGES
wbridges@piii.com

STEPHEN BRIDGES
sbridges@piii.com

20AIChE Spring Meeting 16TH GLOBAL CONGRESS ON PROCESS SAFETY

PROCESS IMPROVEMENT INSTITUTE
Risk and reliability specialists