

**ПНСТ
366.4-2019**



366.4—2019

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: info@interecoms.ru /
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(www.gost.ru)

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6	^
7	
7.1	Λ
7.2 PFD.....	φ
7.3	
8	v
8.1	v
8.2	
9	
10	1
10.1 2	
 1 2.	
10.2 « - - ».....	10
 1 2.	
 « - - ».....	11
10.3 1 2	
 1 2.	
 « - - »,	
	SIL.....	13

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- 2. ;
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- 4.);
(5. ;
- 6. -
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Industrial automation systems and integration. Safety arrangements of industrial plants by means of process control engineering. Part 4. Verification of the hardware of safety instrumented system

— 2020—01—01
2022—01—01

1

(SIL)

(SIS)

(PFD).

2

8

61511-1

1.

61508-6—2012

61508-2

61508-3

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3

FMEDA — (failure mode effect and diagnostics analysis);
 HFT — (hardware fault tolerance);
 — (hard-wired programmed controller);
 MDT — (mean downtime);
 MooN (M-out-of-N) — M N. MSN:
 MTBF — (mean time between failures);
 MTTD — (mean time to detection);
 MTTF — (mean time to failure);
 MTTR — () (mean time to restoration);
 PFD — (probability of failure on demand);
 PFD_{fe} — PFD (PFD of subsystem final element);
 PFD_t — PFD of subsystem logic solver (PFD);
 PFD_{Mw>n} — PFD N (MooN) - (PFD of MooN group in a subsystem of an SIS);
 PFD_s — PFD (PFD of subsystem sensor);
 PFD_{Tout} — PFD SIS (PFD of complete SIS);
 SFF — (safe failure fraction);
 SIF — (safety instrumented function);
 SIL — (safety integrity level);
 SPLC — (safety related programmable logic controller);

T, — ;

X — (,) ;

kg — ;

X_{qD} — ;

\$ — .

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4.1

(fault tolerance):

(61511-1. 3.2.21)

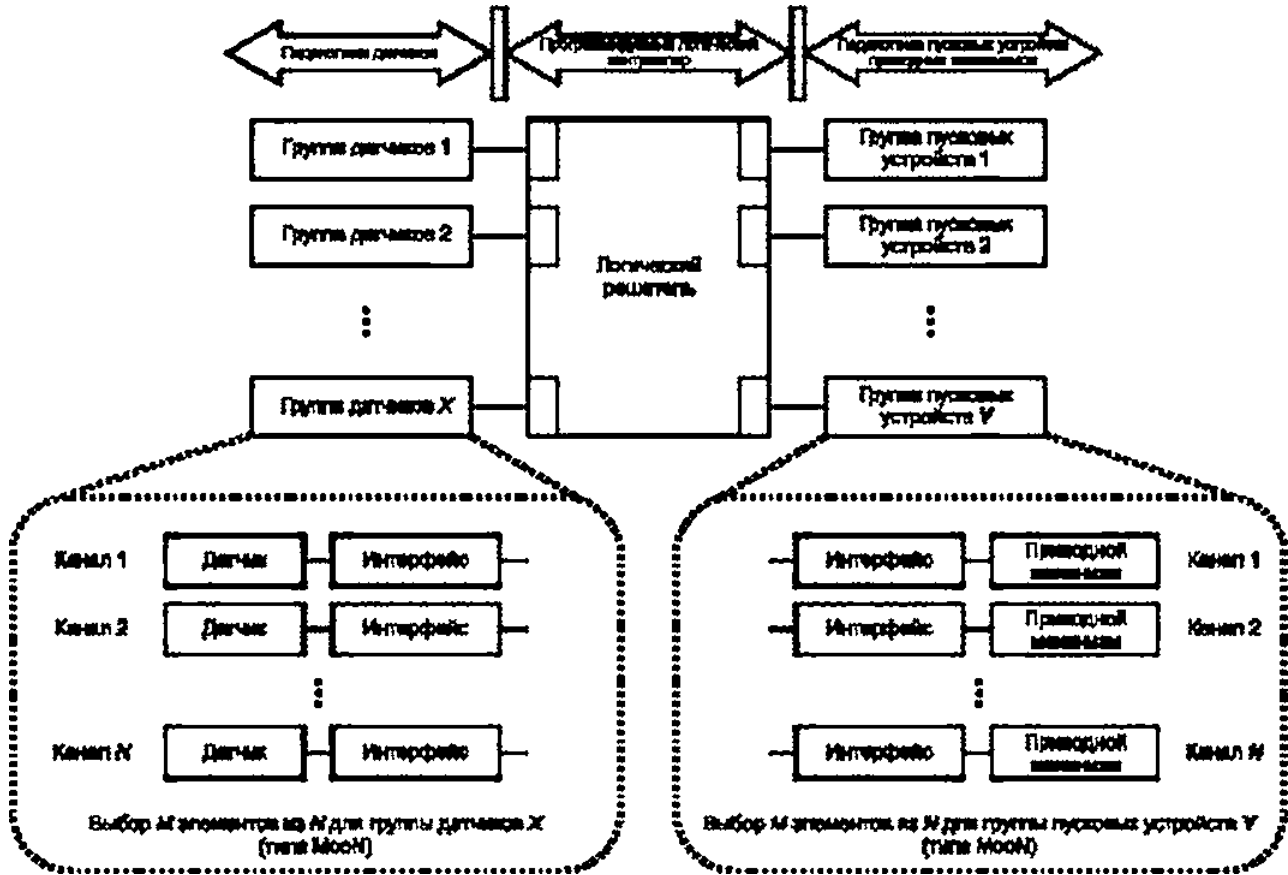
5

(. 1):

- ;

- ;

N N , ())



1—

6

HFT

(HFT 4).

HFT

61511-1.

1 — HFT —

HFT 1

2 — HFT (SIF).

3

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) 3 — , HFT -
 SIL (SIF) (). -
 (.). , -
 SPLC, HFT. -
 « » , -
 .) (, , -
 « ») (, 1. -
 : , ;
 - ;
 : (-
 . « » .).
 1 — HFT SIF.

SiL	HFT	
1	0	1 1.2 2
2	1	1 2.2
3	2	1
4		

1 (. 1). HFT 1,
 HFT1 -
 SIL 1.
 HFT. 1,
 1 (. 2). : (« -
 - »), . 11.5.3 61511-1—2018: (-
 . . .): -
 - (, , .).
 2— HFT -
 SIL (« - - ») SIF.

SiL	HFT	
1	0	1 1.2 2
2	0	1 1.2 2
3	1	1 2.2
4		

7

PFD

PFD

7.1

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(

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SIS.

MDT —
()

MTTR:

$$= MTTD \cdot MTTR.$$

(1)

MTTF

MTBF:

$$MTBF = MTTF + MDT.$$

(2)

(h)

$$MTBF \cdot MTTF.$$

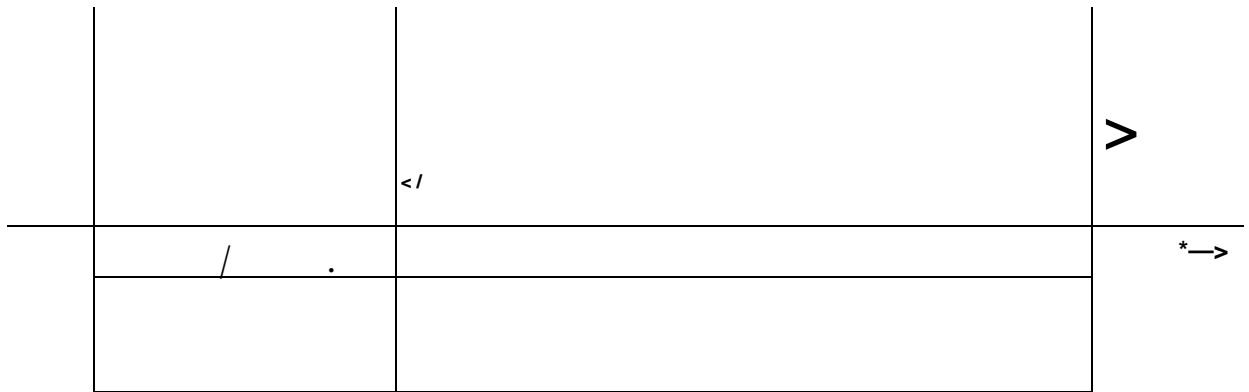
(3)

MTTF —

$$MTTF = -1.$$

(4)

2.



2—

SIS (. PFDfefaj))).

(5):

$$\text{Total MTTF}_{OU} + \text{MTTD}_{OU} + \text{MTTR} = \text{MTBF}_{OU}$$

7.2

PFD

8

7.1.

PFD.

PFD

PFD

SIS
PFD

(PFD_{Total})

(j) PFD_{ToUII}

(6):

$$PFD_{t < 1111} = PFD_s + PFD_l + PFD_{fe}$$

(6)

PFD_{Tols'}

1

1

SIS.

2

MooN.

(l = 1..... Y.

1)

0=1.....X.

1)

l-

PFD_{Gi}

PFD_{Gi}

MooN.

7.3.

Aqu

6

8

7.3

PFD.

7.3

PFD_S

PFD_{6i} i-

PFD_{ie}

PFD_{ij} j-

PFD_S = $\sum PFD_{G1}$ PFD_{kE} = $\sum PFD_{Qj}$ (7)

3

PFD_L

SPLC.

()

PFD

PFD_t

4

PFD_{Total} (6).

PFD

7.3

61508-6.

3. — PFD

3 — PFD

	» * ₋	(001 tool
$PFD_{moj}^{AXdu} 1$	(8)	
$PFD_{tert}^{-} \cdot IL_{p} \cdot IA_{ou} \cdot T_1$	(9)	$PFD_{too2e} \cdot i \cdot PFD_{ool} + PFD_{10<11}$
PFD_{1003}	()	$PFD_{ws}^{-2} \cdot PFD_{H} \cdot PFD_{1001}$
$PFD_{2<k}$	(11)	$2 \cdot PFD_{iao}$
$PFD^{XL} \cdot T.M' \cdot Hou \cdot Ti$	(12)	$PFD_{2)w3} \cdot 4 \cdot PFD_{1+p} \cdot PFD_{lftOI}$

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Moон :

(13)

s N.

(13).

CCF.

D

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1 % 5 %.

PFO.

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Aqq.

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PFO

PFD

8

8.1

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FMEDA.

8

N92

8.2

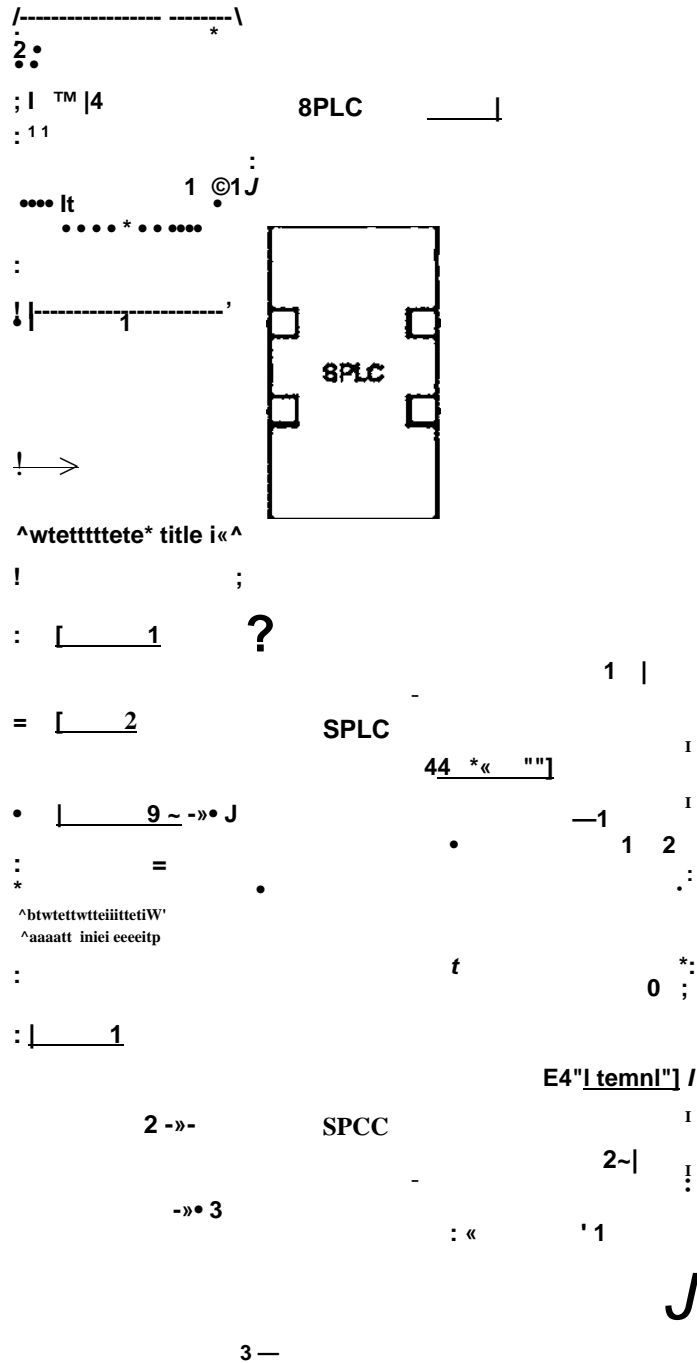
4—

			0
	$1 \cdot 10^{-6} \cdot (MTBF_{OU} = 114)$	8760 = 1	5%
	$5 \cdot 10^{-7} \cdot h^{-1} \cdot MTBF_{jxj} = 228$		
L	$4 \cdot 10^{-7} \cdot h^{-1} \cdot t \cdot MTBF_{pg} = 285$		
F	$1 \cdot 10^{-6} \cdot h^{-1} \cdot t \cdot MTBF_{pg} \gg 114$		
	$4 \cdot 10^{-7} \cdot h^{-1} \cdot MTBF_{jxj} = 285$		

9

SPLC.

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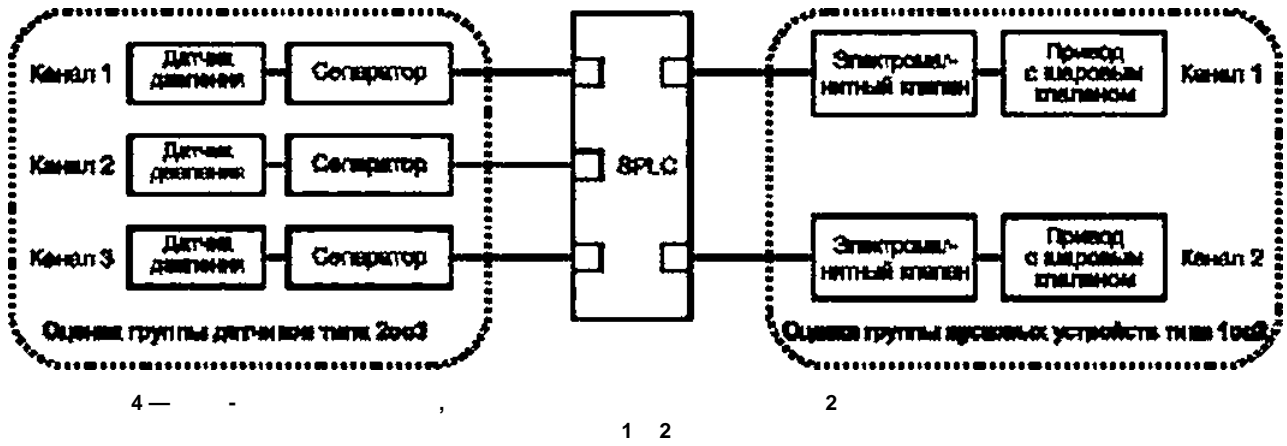
10.1

1 2, , 2 « * * » (. 4)

SPLC (} -

SIL 3.

« - - ». (12) (9). PFD (. 5) - SIL 3.



10.2

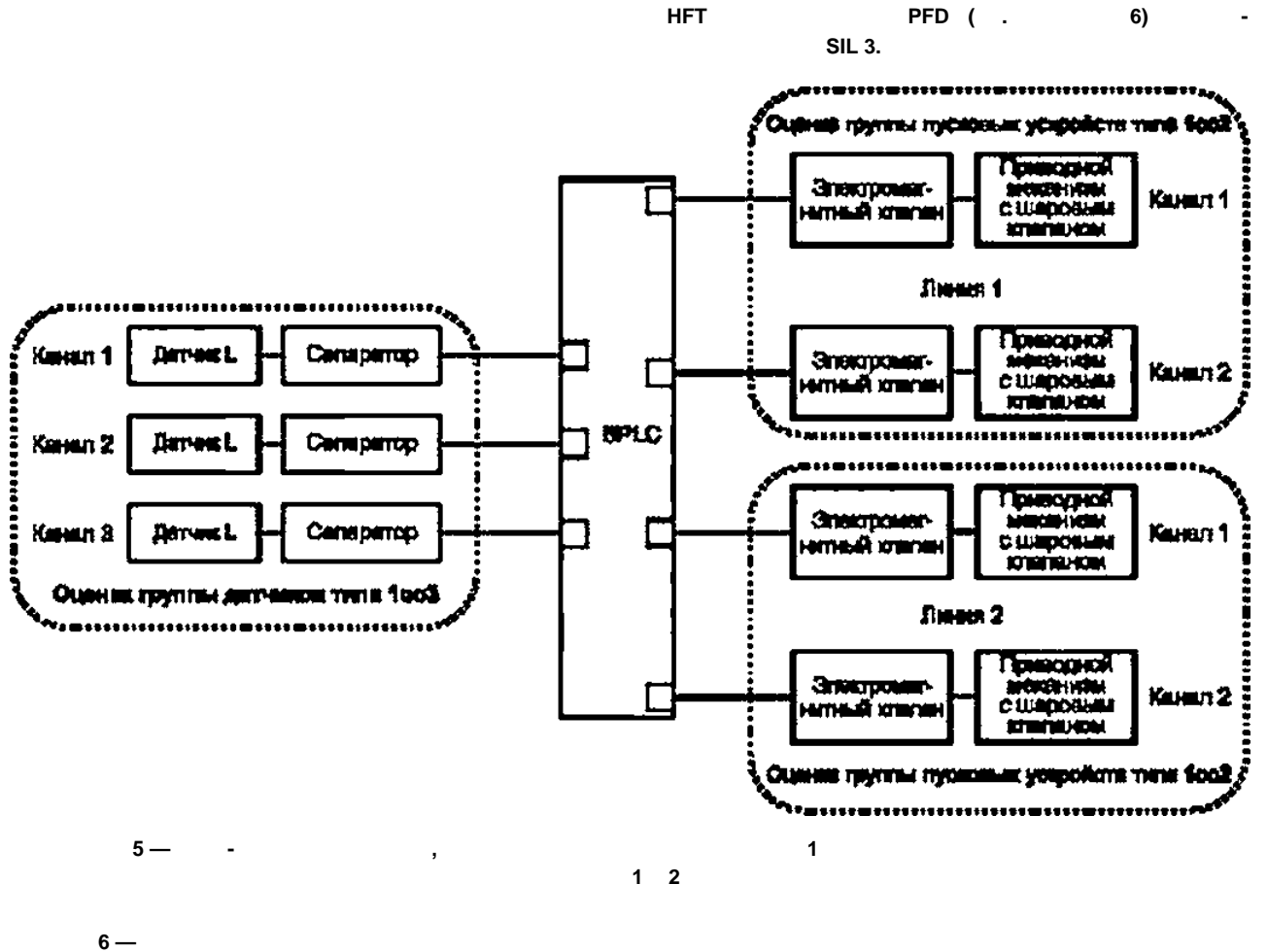
« - - » 1 2, (. - 5)) S PLC (SIL 3. 10.1 « - - ». PFD Moon. PFD PFD PFD 4, 10.1.

5 —

		S PLC.	-
« - - »	« - - »		« - - »
2		—	1 2
HFT			
HFT1		—	HFT1
SIL 3 (2)		SIL 3	SIL 3 (2)
SIL 3			

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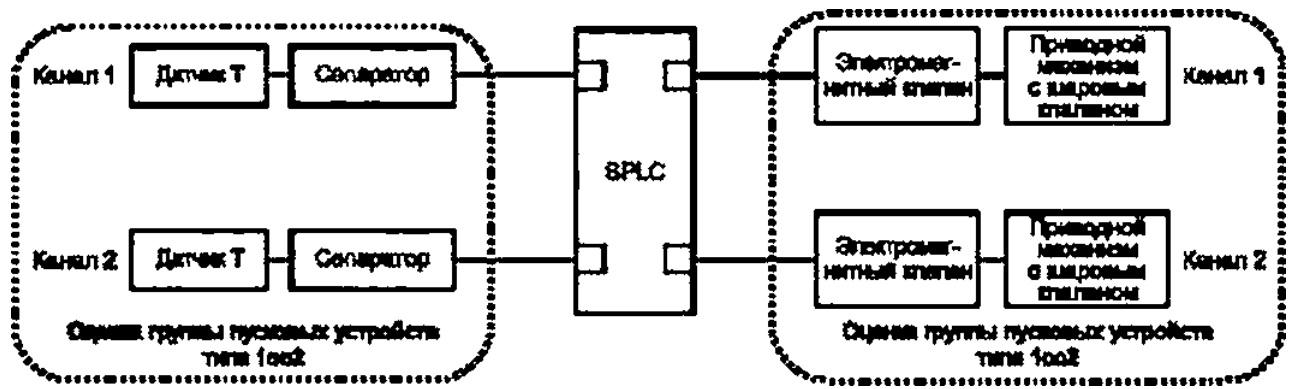
PFD		
$= 1.0 \cdot 10^{-4} \cdot \dots$	—	$= 4.0 \cdot 10^{-7} \dots$
$\dots = 6760 \dots = 1$	$\dots = 87600 \dots = 10$	$Tf = 8760 \dots = 1$
$= 5\%$	—	$= 5\%$
$PFD_S = 3.0 \cdot 10^{-4}$	$PFD. = 1.0 \cdot 10^{-5}$	$PFDpg = 9.2 \cdot 10^{-5}$
$PFD_{Tp>1} = 4,0 \cdot 10^{-4}$ —	SIL 3	



L	SPLC.		
« - - »	» - -	« - - »	« - - »
1	—	1 2	
HFT			
HFT2	—	HFT 1	
SIL 3 (2)	SIL 3	SIL 3 (2)	
SIL 3			

PFD		
$= 4.0 \cdot 10^{-7} \cdot \dots$	—	$= 4.0 \cdot 10^{-7} \cdot \dots$
, = 8760 = 1	, = 87600 = 10	, = 8760 = 1
0 = 5%	—	=5%
$PFD_s = 9.2 \cdot 10^5$	$PFD = 1.0 \cdot 10^5$	$PFD = 2 \cdot 9,2 \cdot W^5$
$PFDy^{\wedge} = 2.8 \cdot 10^{-> -^*$	SIL 3	

10.3 1 2, « - - », SIL 3. 6. SPLC () SIL 3. HFT 61508. HFT 61508. HFT () SIL 2. 7).



6 — 1 2 1 2

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7 —

		SPLC.			
SIL 2. HFT 0	- - -	SIL 2. HFT 0	- - -	SIL 2. HFT 0	- - -
1 2		—		1 2	
HFT					
HFT 1		—		HFT 1	
SIL 2	SIL 3	SIL3	SIL 3	SIL 3 (2)	
SIL 2					
PFD					
$= 1.5 \cdot 10^{17} \cdot \dots + 1.0 \cdot 10^{17} \cdot \dots$		—		$= 1.0 \cdot 10^{-7} \cdot h^{11} + 4.0 \cdot 10^{-7} \cdot h^{-1}$	
$f = 8760 = 1$		$, = 87600 = 10$		$f = 8760 = 1$	
$= 5\%$		—		$6 = 5\%$	
PFD _S = $5.6 \cdot 10^{-5}$		PFD. = $1.0 \cdot 10^{-5}$		PFD _„ = $1.2 \cdot 10^{**}$	
PFD _{Трпjt} = $1.9 \cdot 10^{-4}$ —			SIL 3		

« ... ».

4

PFD ()

() , PFD 10.1.

PFD_S ()

8

()

$1.5 \cdot 10^{-7}$

- ^ -1.

« ... ».

PFD_{f6} ()

X_{DU}

4.0 10^{17} -1 (.) 4). 8

Aqu $1,0 \cdot 10^{-7}$ -1.

HFT

SIL 2 ()

PFD

SIL 3.

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10—2019/8

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15.10 2019.

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