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The Radsetta Stone - Establishing a Common Environment Taxonomy Across Space Nuclear Technologies

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“High temperature” “Long duration” “Rad hard”

Application	Temperature [K]	Ref.
NTP – NERVA	3 - 3000	8
NEP – JIMO	3 - 1150	9
FSP – 2025	18 - 1100	4
Ambient – Space	3 - ???	
Ambient – Lunar	18 - 391	5
Ambient – Martian	134 - 310	10
Terrestrial PWR	293 - 500	7

Application	Neutron fluence [n/cm^2]	Ref.
NTP – NERVA	$2x10^{16}$	2
NEP – JIMO	$5x10^{10}$	3
FSP – 2025	$5x10^{14}$	4
Ambient – Space	0	1
Ambient – Lunar (1 yr)	$2x10^{9}$	5
Ambient – Martian (1 yr)	$5x10^{7}$	6
Terrestrial PWR (1yr)	~$5x10^{20}$	7

<u>What about:</u> Dose? Chemical compatibility? Linear energy transfer? Exposure time? Pressure? Static/dynamic loads?

- How do we maintain nuance without overcomplicating communication?
- How do effectively communicate without oversimplification? TRL?

Radsetta Stone

Symbol	Parameter	Unit
T	Temperature	K
Φ_{nt}	Neutron fluence below 100 keV	particle/cm^2
Φ_{nf}	Neutron fluence above 100 keV	particle/cm^2
D_γ	Ionizing γ dose	krad
LET_{th}	Linear energy transfer threshold for effect at 1E7 ions/cm^2	MeV-cm^2/mg
a	Acceleration	g
P	Pressure	Torr
Chem	Chemical compatibility	N/A
t	Exposure time	s

T
< 30
< 77
< 150
< 200
295
< 400
< 800
< 1400
< 2000

Φ_{nt}
N/A
< 1E5
< 1E7
< 1E9
< 1E11
< 1E14
< 1E18
< 1E21
< 1E24
< 1E27

Φ_{nf}
N/A
< 1E5
< 1E7
< 1E9
< 1E11
< 1E14
< 1E18
< 1E21
< 1E24
< 1E27

D_γ
N/A
< 1E2
< 1E3
< 1E4
< 1E5
< 1E6
< 1E7
< 1E8
< 1E9
< 1E10

LET_{th}
N/A
< 10
< 20
< 37
< 75
< 100

a
N/A
< 1
< 7
< 15
< 20
< 40
< 60

P
< 1E-5
< 1E-3
< 1E-1
760
< 1E3
< 1E4
< 1E5

Chem
N/A
Highly oxidizing
Moderately oxidizing
Neutral
Moderately reducing
Highly reducing

t
< 6E1
< 4E2
< 9E4
< 6E5
< 3E6
< 3E7
< 3E8

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A customer's requirements


[4]

Symbol	Parameter	Unit
T	Temperature	K
Φ_{nt}	Neutron fluence below 100 keV	particle/cm^2
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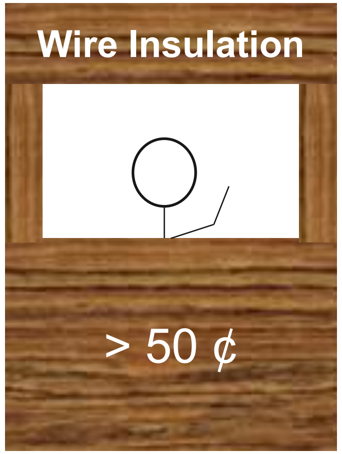
P	Pressure	Torr
Chem	Chemical compatibility	N/A
t	Exposure time	s

T	Φ_{nt}	Φ_{nf}	D_γ	LET_{th}	a	P	Chem	t
< 30	N/A	N/A	N/A	N/A	N/A	< 1E-5	N/A	< 6E1
< 77	< 1E5	< 1E5	< 1E2	< 10	< 1	< 1E-3	Highly oxidizing	< 4E2
< 150	< 1E7	< 1E7	< 1E3	< 20	< 7	< 1E-1	Moderately oxidizing	< 9E4
< 200	< 1E9	< 1E9	< 1E4	< 37	< 15	760	Neutral	< 6E5
295	< 1E11	< 1E11	< 1E5	< 75	< 20	< 1E3	Moderately reducing	< 3E6
< 400	< 1E14	< 1E14	< 1E6	< 100	< 40	< 1E4	Highly reducing	< 3E7
< 800	< 1E18	< 1E18	< 1E7		< 60	< 1E5		< 3E8
< 1400	< 1E21	< 1E21	< 1E8					
< 2000	< 1E24	< 1E24	< 1E9					
	< 1E27	< 1E27	< 1E10					

Driven by environment definitions



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A supplier's capability

Symbol	Parameter	Unit
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T	Φ_{nt}	Φ_{nf}	D_γ	LET_{th}	a	P	Chem	t
< 30	N/A	N/A	N/A	N/A	N/A	< 1E-5	N/A	< 6E1
< 77	< 1E5	< 1E5	< 1E2	< 10	< 1	< 1E-3	Highly oxidizing	< 4E2
< 150	< 1E7	< 1E7	< 1E3	< 20	< 7	< 1E-1	Moderately oxidizing	< 9E4
< 200	< 1E9	< 1E9	< 1E4	< 37	< 15	760	Neutral	< 6E5
295	< 1E11	< 1E11	< 1E5	< 75	< 20	< 1E3	Moderately reducing	< 3E6
< 400	< 1E14	< 1E14	< 1E6	< 100	< 40	< 1E4	Highly reducing	< 3E7
< 800	< 1E18	< 1E18	< 1E7		< 60	< 1E5		< 3E8
< 1400	< 1E21	< 1E21	< 1E8					
< 2000	< 1E24	< 1E24	< 1E9					
	< 1E27	< 1E27	< 1E10					

Driven by technology capability

Radsetta Stone

- Identify customer overlaps
- Identify technology gaps
- Communication tool
  - Common taxonomy
  - Preserve nuance
  - Lightweight

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< 1400	< 1E21	< 1E21	< 1E8					
< 2000	< 1E24	< 1E24	< 1E9					
	< 1E27	< 1E27	< 1E10					

Bibliography

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