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LPFRS / RMO / HPFRS / MCFRS STARLPRO Rubidium Clock Lifetime and MTBF

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Life Time

The aging of the Rb lamps due to the diffusion of rubidium metal into the glass walls of its bulbs, has been previously studied by Mr, C.-H. Volk and Mr, R.-P. Frueholz, of Aerospace Corporation, CA, USA.

These studies have been carried out using the differential scanning calorimetry technique.

The calorimetric technique measures the elemental Rubidium content in a lamp used in normal conditions.

TNT is using the SCHOTT glass 8436 type, which has been proved to be presently the best alkali resistant glass on the market .

The figure 1 shows the rubidium consumption of a lamp made of SCHOTT 8436 glass, and shows a logarithmic curve of the rubidium consumption, which is approximately 100 µg after a period of one year of operation.

Together with the Observatory of Neuchâtel, TNT performed the same measurement on one sample lamp n° 2285, in order to confirm the Aerospace Corporation data. A very similar characteristics was obtained (see figure 2).

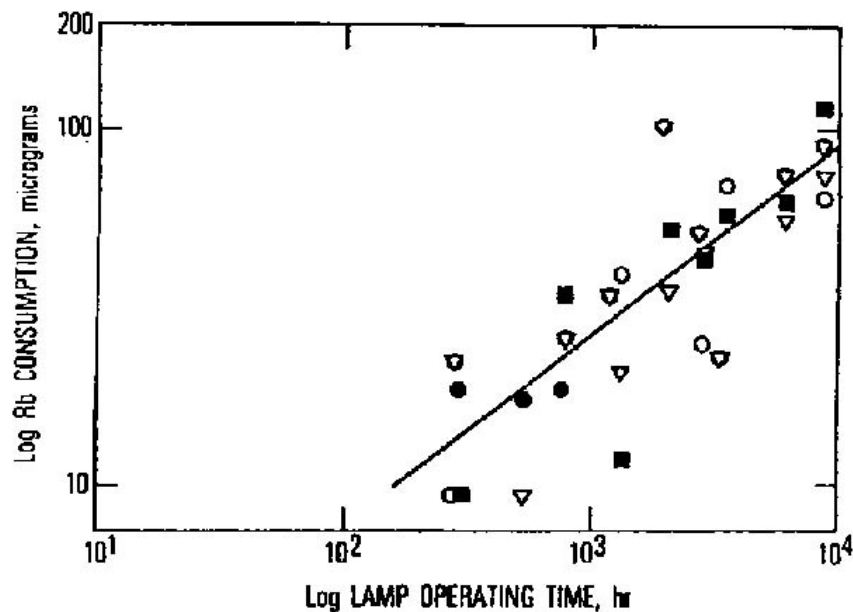


Fig 1: Aerospace corp. data

These Rb consumption characteristics vary according to the square root of time:

$$M(t) = (0.9 \pm 0.15) \times \sqrt{t}$$

where: M=Rb mass in mg
t=time, in hours

After 20 years of operation, M = 376 µg.

The rubidium lamps manufactured by T.N.T. are filled with 700 µg to 1000 µg of rubidium.

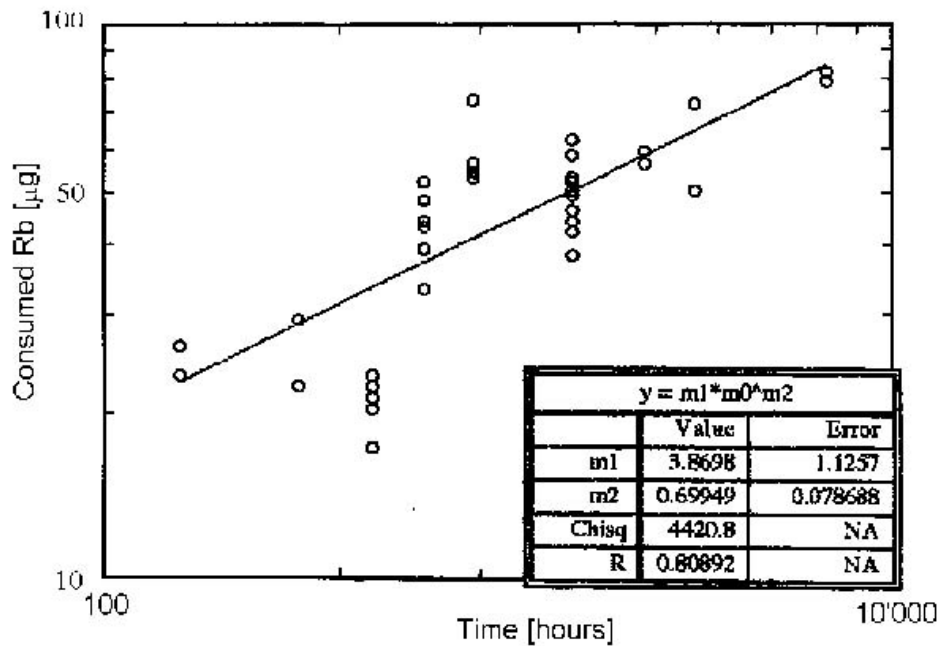


Fig 2: ON/TNT data

Consequently, the average life time, according to the diffusion of the rubidium into the glass walls, is:

$$t[h] = \left(\frac{700}{1.05} \right)^2 = 444'444 \text{ hours (50 years)}$$

MTBF Calculation

LPFRS / RMO / HPFRS-02

System MTBF Report								
System Data			Records: 3	File Rev : 6	Model: Active K-of-N	MIL-HDBK-217F		
Miniature Rubidium clock			Basic FR= 4.0066 f / million hours			MTBF= 249585.1260 hours		
Rec #	DC	Qty	TFR [%]	FR	File rev	Env	°C	Parts
1	Circuit: CELLASSY			LPFRS/RMO/HPFRS-02 CELL ASSEMBLY				
	100%	1	0.025050 [0.63%]	0.025050	5	GB	25°C	3
2	Circuit: LAMPASSY			LPFRS/RMO/HPFRS-02 LAMP ASSEMBLY				
	100%	1	0.027194 [0.68%]	0.027194	6	GB	25°C	8
3	Circuit: MAIN BOARD			LPFRS/RMO/HPFRS-02 MAIN BOARD				
	100%	1	3.9544 [98.7%]	3.9544	36	GB	25°C	152

MCFRS

System MTBF Report								
System Data			Records: 5	File Rev : 6	Model: serial	MIL-HDBK-217F		
Miniature Rubidium clock			Basic FR= 5.1815 f / million hours			MTBF= 192993.6333 hours		
Rec #	DC	Qty	TFR [%]	FR	File rev	Env	°C	Parts
1	Circuit: MOTHER2			LPFRS/RMO/HPFRS-02 CELL ASSEMBLY				
	100%	1	1.4408 [27.81%]	1.4408	11	GB	22°C	108
2	Circuit: PROC2			LPFRS/RMO/HPFRS-02 LAMP ASSEMBLY				
	100%	1	1.6765 [32.35%]	1.6765	8	GB	22°C	98
3	Circuit: FCELL2			LPFRS/RMO/HPFRS-02 LAMP ASSEMBLY				
	100%	1	0.049847 [0.96%]	0.049847	2	GB	22°C	6
4	Circuit: FLAMP2			LPFRS/RMO/HPFRS-02 LAMP ASSEMBLY				
	100%	1	0.032640 [0.63%]	0.032640	1	GB	22°C	3
5	Circuit: OSCMU3			LPFRS/RMO/HPFRS-02 MAIN BOARD				
	100%	1	1.7396 [33.57%]	1.7396	3	GB	22°C	124

StarLPRO

System MTBF Report								
System Data			Records: 3	File Rev : 1	Model: serial	Bellcore 6		
Miniature Rubidium clock			Basic FR= 2.5096 f / million hours			MTBF= 398'461.646 hours		
Rec #	DC	Qty	TFR [%]	FR	File rev	Env	°C	Parts
1	Circuit: MAIN BOARD			StarLPRO MAIN BOARD				
	100%	1	2.169 [86.45%]	2.169	1	GB	25°C	333
2	Circuit: CELL and LAMP			StarLPRO CELL and LAMP ASSEMBLY				
	100%	1	0.216 [8.61%]	0.216	1	GB	25°C	23
3	Circuit: OSCILLATOR			StarLPRO OSCILLATOR ASSEMBLY				
	100%	1	0.124 [4.94%]	0.124	1	GB	25°C	39