Mini Review

BIOMEDICAL Journal of Scientific & Technical Research

ISSN: 2574 -1241

DOI: 10.26717/BJSTR.2024.56.008913

Examination on Updating the Life of Mechanical Product in Transportation Arranged in Quantum-Ferried Life Protype and Sample Size

Seongwoo Woo* and Song-Jung Kim

Myungsung Medical College, Ethiopia

***Corresponding author:** Seongwoo Woo, Myungsung Medical College, Ethiopia

ARTICLE INFO

Received: May 21, 2024

Published: June 03, 2024

Citation: Seongwoo Woo and Song-Jung Kim. Examination on Updating the Life of Mechanical Product in Transportation Arranged in Quantum-Ferried Life Protype and Sample Size. Biomed J Sci & Tech Res 56(5)-2024. BJSTR. MS.ID.008913.

ABSTRACT

To upraise the fatigue lifetime of mechanical product randomely shaked during transportation, parametric Accelerated Life Testing (ALT) is offered as structured way, which is produced in sample size and life–stress model. These organized steps let designer to detect the design frailty which has a noteworthy effect in product reliability. In the long run, company can bring to cease recalls from the marketplace. For a manifestation, elevating the lifetime of system worked by machinery in transportation was inspected [1].

Keywords: Parametric ALT; Product Functioned by Machine; Transportation; Fatigue; Design Frailty

Introduction

The system functioned by machinery brings (produced) power to maintain an organized effect that entails movement & forces and gets mechanical advantages by precisely realizing undisclosed mechanisms. By conducting the vapor compression cycle, a domestic refrigerator lets cooled air from evaporator to refrigerator and freezer division. In the meantime, foods in refrigerator and freezer department may be held recently. Refrigerator is arranged of compressor, condenser, capillary, and evaporator [2]. It might be designed to correctly function over the conditions truly deployed by the consumer. If there are design frailty, product may not instantly function in its assumed lifetime (Figure 1). As finding design frailty by reliability testing and modifying it, an engineer can optimally function it [1]. This organized procedure detains:

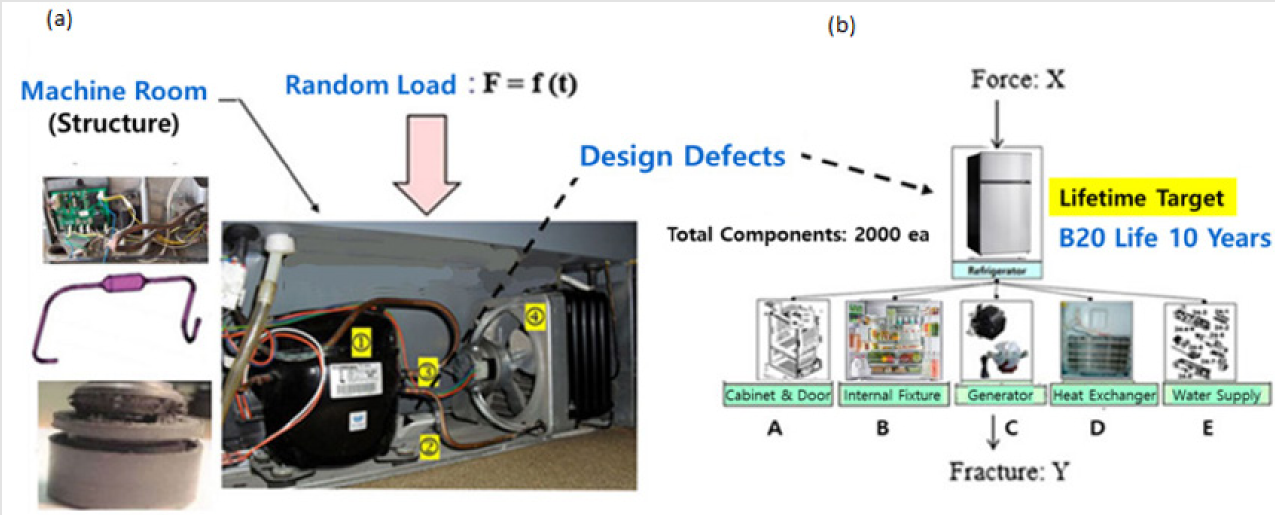
(1) ALT scheme,

(2) Load scrutiny,

(3) ALTs with modifications, and

(4) The consideration to discern whether product gets to the designed BX life. For a case investigation, the mechanical product during transportation will be inspected.

DOI: 10.26717/BJSTR.2024.56.008913



Note: (a) Mechanical department: compressor [1], (b) Modules A-E in the refrigerator
rubber [2], connecting tubes [3],
and fan and condenser [4].

Figure 1: Mechanical compartment in a domestic refrigerator.

Parametric ALT in System Functioned by Machinery

Finding in the Schrodinger's mathematical problem can be discovered:

$$-\frac{h^2}{8\pi^2 m}\frac{d^2\varphi_n(x)}{dx^2}=E_n\varphi_n;\varphi_n(x)=\sqrt{\frac{2}{a}}\sin(\frac{n\pi}{a})x;E_{n=}\frac{n^2h^2}{8ma^2}n>0 \quad (1)$$

Linear transport shall be indicated:

$$J = LX \quad (2)$$

For an incident, solid-state diffusion, J, shall be condensed

$$J = B\sinh(aS)\exp\left(-\frac{E_a}{kT}\right) \quad (3)$$

When Equation (3) takes the reverse, the life-stress (LS) model can be elucidated:

$$TF = A\left[\sinh(aS)\right]^{-1}\exp\left(-\frac{E_a}{kT}\right) \quad (4)$$

Term$\left[\sinh(aS)\right]^{-1}$ in Equation (4) has some traits: 1) $(S)^{-1}$ in the initiation has some linear result, 2) $(S)^{(-n)}$n) is found in the middle, and 3) $(e^aS)^{(-1)}$ in the finish is too large. On the midway, ALT is achieved. Because the stress comes from effort in transferring power, Equation (4) shall be indicated:

$$TF = A(S)^{-n}\exp\left(\frac{E_a}{KT}\right)=B(e)^{-\lambda}\exp\left(\frac{E_a}{KT}\right) \quad (5)$$

To find the acceleration factor (AF), announced by the relation between the elevated-level stress and common stress, AF may be expressed as:

$$AF = A\left(\frac{S_1}{S_0}\right)^n\left[\frac{E_a}{K}\left(\frac{1}{T_0}-\frac{1}{T_1}\right)\right]=\left(\frac{e_1}{e_0}\right)^\lambda\left[\frac{E_a}{k}\left(\frac{1}{T_0}-\frac{1}{T_1}\right)\right] \quad (6)$$

To reach the allocated time for designed lifetime - B1 life of ten years, sample size united by Equation (6) can be indicated as [2]:

$$n \geq (r+1).\frac{1}{x}.\left(\frac{L^*_{BX}}{AF.h_a}\right)^\beta + r$$

Case Examination: Refurbishing the Fatigue Lifetime of a Household Product Subjected to Random Shakes in Transported by Railroad

Refrigerators were conveyed from the LA situated in the western coast of the U.S. to consumers who lived in the US, the part of the country near the Atlantic Ocean. This trip for an entire travel period – seven days – was 7,200 km. As uttered by market data, after products subjected to random vibrations on rail transit way were transported, refrigerators did not work because the mount rubbers & soldering in compressor were fatigued and the connecting tubes were broken, going along with engineers to request for taking the place of it. Namely, in the US, the interval when earliest failure occurred for two days was approximately 2,500 km during rail transportation. In Chicago, 27% of the carried refrigerators was failed. As the products transported the 7,200-km distance from the western coast of the U.S. to Boston, 67% of the refrigerators was failed. It was evident that the unsuccessful refrigerator had design frailties. To rightly work the product within its assumed lifetime during transportation, as recognizing them by parametric ALT, the company had to alter them (Figure 2). Because of the basis load, Y, force transmissibility, Q, may be defined:

$$Q = X(t)/F_T(t) = X(t)/Y(t) = \left[\frac{\left(2\varsigma \frac{f_n}{f}\right)^2}{\left(1-\left(\frac{f_n}{f}\right)^2\right)^2 + \left(2\varsigma \frac{f_n}{f}\right)^2} \right]^{1/2} \quad (8)$$

where X is the unchanging solution on the mechanical system, FT is the applied force, Y is the extent of foundation excitations, r is the frequency ratio $(= w_n / w = f_n / f_n / f)$, ς is the damping proportion $(c/c_c = c/2w_n)$, K is the spring constant.

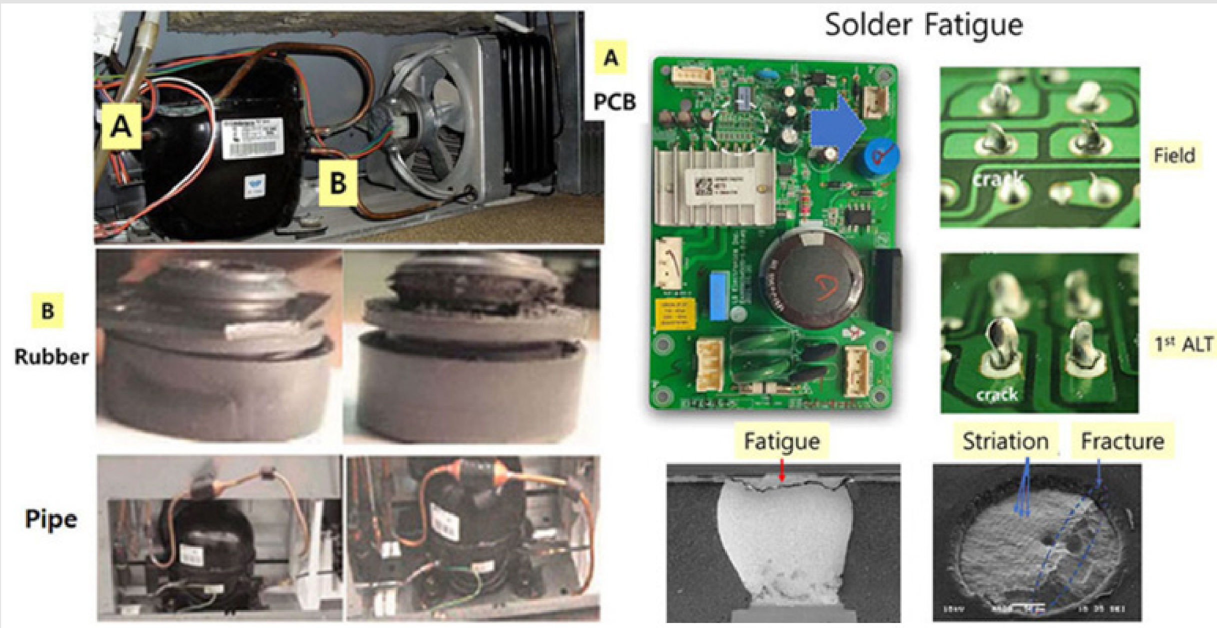


Figure 2: Failed product from the field.

As the stress during transit originates from the transported vibration loads, FT, which can be expressed as the power spectral density (PSD) of acceleration on the regulated frequency band, Equation (5) can be defined:

$$TF = A(S)^{-n} = B(F_T)^{-\lambda} \quad (9)$$

So, discovered on Equation (6), AF may be indicated:

$$AF = \left(\frac{S_1}{S_0}\right)^n = \left(\frac{a_1}{a_0}\frac{X}{Y}\right)^\lambda = (R \times Q)^\lambda \quad (10)$$

where a1 is the elevated PSD on the assigned frequency band, a0 is the common PSD on the assigned frequency band, R, is amplitude proportion of gravitational acceleration. As inspecting the computed vibration, the natural frequencies for horizontal and vertical vibration were 5 Hz and 9 Hz. The damping proportion was anticipated to be $\varsigma = 0.1$ with a settling period of 2 sec and approximately 5.3 overshoot. The frequency ratio at the natural frequency ω_n also was anticipated to be r $r(= w/w_n) = 1$.

To attain the AF of random shakes found from the field, elevated PSD to the product were applied to the shaking table for each orientation (Figure 3). From Equation (8), the force transmissibility, Q, had the magnitude of approximately 5.3. Due to acceleration of 1 Grms, the AF was 4.0, roughly calculated to that of worst-case of 0.25 Grms. Employing a cumulative damage constant, λ, of 2.0, the entire AF from Equation (10) was set to be 450.0. As the calculated shape parameter on Weibull plot was 6.41 and the life aim – B1 life for the whole travel distance had, for three samples, the test time attained from Equation (7) was approximated to have 40 min. Namely, if the refrigerator was failed less than once in assigned period – 40 min., product was suitable for the whole travel distance of 7,200 km to live the product fatigued because of random vibration.

DOI: 10.26717/BJSTR.2024.56.008913

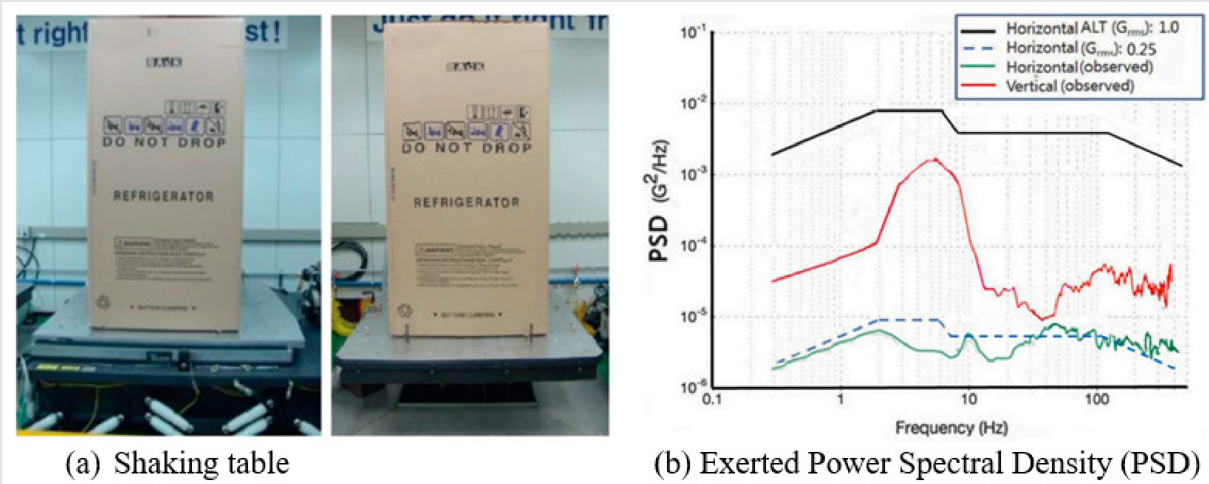


Figure 3: Scheduled PSD in shaking bench.

Results and Conclusions

In the 1st ALT, the unsuccessfulness for the stress — 1.00 Grms at the natural frequency $(r = 1.0, \varsigma \approx 0.1)$ were found. Namely, for these circumstances, at 20 min, mount rubber & soldering were fatigued and tubes on the samples were broken. It happened because of no pillar in the area of stress raiser for the mount rubber to endure the random loads because of parallel vibrations. As action plans, the product was redesigned as the altered rubber mount in compressor, C1 (Figures 4 & 5). In 2nd ALT, the product is successful till 60 min. When product reached at an acceleration of 1.00 Grms in the shake table, the natural frequency on the parallel direction was altered from 5Hz to 8 Hz by the enlarged damping (Figure 6). To enlarge the fatigue lifetime of refrigerator during transit, ALT was developed. The quantum-conveyed life-stress model and sample size were suggested. As an occasion inpsection, enhancing the lifetime of a product fatigued by random vibrations in rail transportation was investigated. As the mount rubbers in compressor was redevised, there were no issues for assigned time – 40 min. So, the product was assured to endure the fatigue produced and fulfil the refrigerator lifetime – B1 life for the whole travel distance.

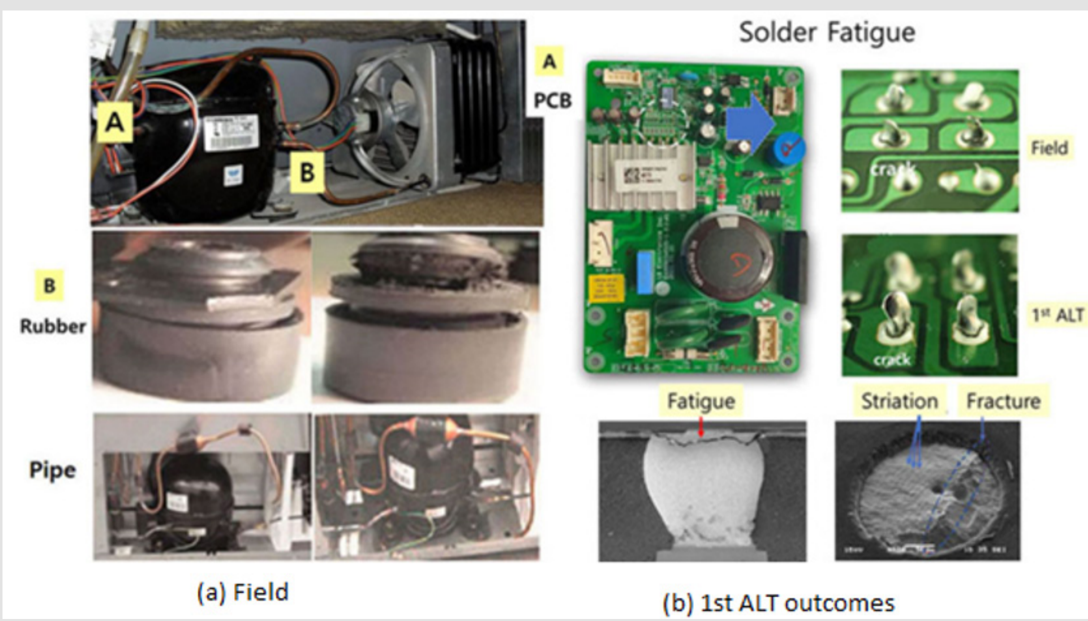


Figure 4: Damaged refrigerator from the marketplace and 1st ALT.

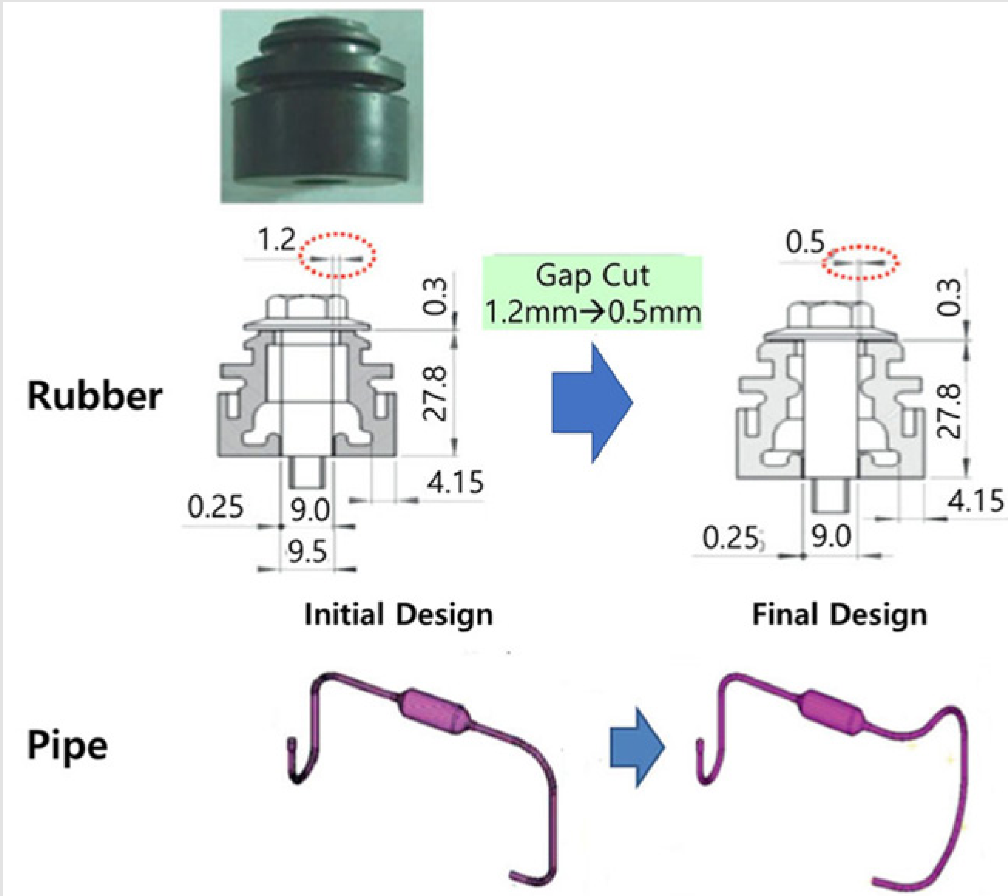


Figure 5: Design modifications.

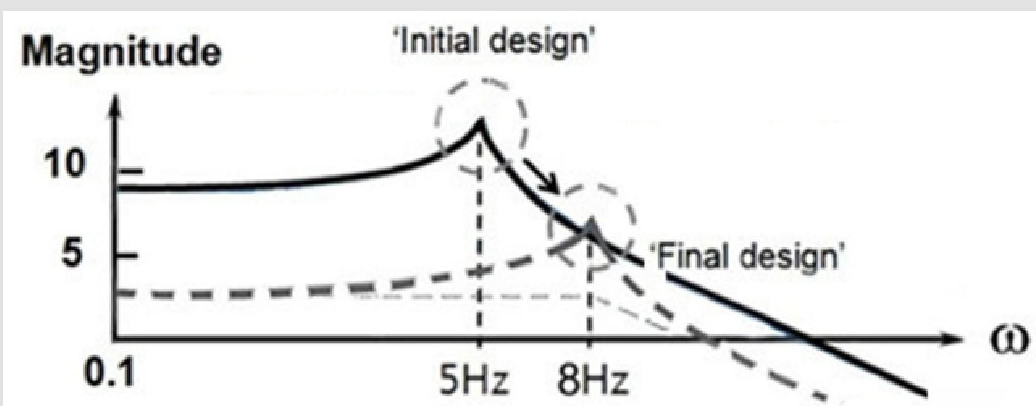


Figure 6: Changed natural frequency in the horizontal vibration.

References

1. Woo S, O'Neal D, Pecht M (2023) Improving the lifetime of mechanical systems during transit established on quantum/transport life-stress prototype and sample size, Mechanical Systems and Signal Processing 193: 110222.
2. Woo S, Pecht M, O'Neal D (2020) Reliability design and case study of the domestic compressor subjected to repetitive internal stresses, Reliability Engineering and System Safety 193: 106604.

ISSN: 2574-1241

DOI: 10.26717/BJSTR.2024.56.008913

Seongwoo Woo. Biomed J Sci & Tech Res