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METHODS FOR DEFINING OF A MANUFACTURER'S WARRANTY EXPECTED COSTS

The paper presents the methods for defining a manufacturer's expected costs for warranty mainte-nance of products. It is shown how to calculate the cost of warranty repairs, with the failure rate of radio-electronic equipment at the design phase taken into account, and put them into the structure of a product's price, with the duration of warranty borne in mind. Having estimated the expected cost of warranty, a manufacturer can reduce costs by making a reserve fund for warranty service that allows saving money on profit tax.

Keywords: *warranty, repair cost, failure, failure rate, radio-electronic equipment, reserve fund, profit tax.*

Introduction

It is known that some warranty has to cover radio-electronic equipment produced by the Russian industry, so a manufacturer shall be obliged to eliminate drawbacks in previous services for the defined term.

According to GOST RB 15.306-2003, warranty is a supplier's (contractor's) obligation to guarantee to the customer (consumer) that the quality of products (services) supplied is in compliance with the standards, specified technical conditions and (or) contract's provisions during the defined term (warranty period), and the obligation to eliminate, gratis and within the term specified by the warranty, the defects of products (services) revealed during the warranty period by repairing or replacing defective products (components), provided that the consumer follows the specified conditions of operation (use), keeping and transporting [1].

However, the cost of warranty obligations is often not included into the structure of the price of prod-ucts produced by manufacturers. In this case the funds required for warranty repairs are taken from a company's profit or the funds allocated to other orders. On top of that, warranty periods can vary quite significantly – sometimes radically – for products of the same type.

Since there are no common methods for estimating warranty expected costs, none has calculated a manufacturer's costs for warranty maintenance beforehand.

In this paper we have attempted to estimate costs of warranty obligations, with the failure rate of com-ponents of manufactured products and the duration of these obligations taken into account. We have also studied models for making reserve funds by manufacturers for warranty maintenance, referring to the fact that according to the Russian Tax Code, funds put in these reserves are not taxable.

1. Estimation of warranty obligations cost in case of common warranty periods of a product's components

Products generally consist of commercially available off-the-shelf (COT) items and locally produced items, and their warranty periods can be either similar or different.

Let us study the first case when the warranty periods are similar.

In this case the warranty repair expected cost (a manufacturer's expenditures) over the warranty period ($C_{\text{ГР изд}}$) is defined by the following formula (1):

$$C_{\text{ГР изд}} = \left[\sum_{i=1}^{m} C_{\text{ГР}\,i} \cdot (r_{\text{РАБ}\,i} + r_{\text{ХР}\,i}) \right] \cdot T_{\text{Г изд}}, \tag{1}$$

where $C_{\text{ГР}\,i}$ (rubles) is the average cost of single warranty repair of the i-th locally produced item and defined by the expert method upon results of operation of identical items (as practice shows, the value $C_{\text{ГР}\,i}$ usually makes up about 30-50% of the cost of the i-th item);

$T_{\text{Г изд}}$ (years) is the warranty period (warranty service period) of a product specified by Technical Conditions;

$r_{\text{раб}\,i}$ and $r_{\text{хр}\,i}$ is the total number of the i-th locally produced item's failures expected for one year of warranty obligations during the operation and keeping of the item respectively.

Values of $r_{\text{раб}\,i}$ и $r_{\text{хр}\,i}$ are defined by formulas (2) and (3) respectively:

$$r_{\text{раб}\,i} = A \cdot N_i \cdot \lambda_i \cdot Q, \tag{2}$$

$$r_{\text{хр}\,i} = 0{,}02 \cdot A \cdot N_i \cdot \lambda_i\,(1 - Q), \tag{3}$$

Q is the coefficient of the technical use of the product. According to GOST R 27.002-2009, it is the proportion of a product's availability in relation to the total operation period within the specified time interval, including all types of technical maintenance [2]. The value of Q is defined by the technical requirements for a product fixed in the technical specification or upon results of testing analogous products;

λ_i (1/time) is the failure rate of the i-th locally produced item. It is defined by the calculation method at the stage of technical design or technical specifications and specified in reliability calculations (can be also defined by the technical conditions for items);

N_i is the total number of the i-th locally produced item;

A is the number of hours in a year (equals to 8760);

Note: The coefficient 0.02 in the formula (3) is a result of comparison of the basic failure rate ($\lambda_{\text{б}}$) of radio-electronic equipment and the failure rate of storage ($\lambda_{\text{хр}}$), specified in Guide 22 TSNII MO RF dated 2006, and equals to the correlation between the failure rates of radio-electronic equipment in off and on modes.

The expression in formula (1) can be significantly simplified if we assume for calculations that the average cost of single warranty repair is similar for all types of locally produced items.

In this case the value of $C_{\text{ГР изд}}$ can be defined by the following formula (4):

$$C_{\text{ГР} \, u3\partial} = C_{\text{ГР}} \cdot (r_{\text{РАБ}} + r_{\text{ХР}}) \cdot T_{\text{Г} \, u3\partial},$$ (4)

where $C_{\text{ГР}}$ is the average cost of the warranty repair of a single locally produced item;

$r_{\text{раб}}$ и $r_{\text{хр}}$ is the total number of a locally produced item's failures expected for one year of warranty obligations during the operation and keeping of the item respectively.

The values of $r_{\text{раб}}$ и $r_{\text{хр}}$ are defined by formulas (5) and (6):

$$r_{\text{раб}} = A \cdot \lambda_{\Sigma} \cdot Q,$$ (5)

$$r_{\text{хр}} = 0{,}02 \cdot A \cdot \lambda_{\Sigma} \, (1 - Q),$$ (6)

λ_{Σ} is the total number of a locally produced item's failure rate which is defined by formula (7):

$$\lambda_{\Sigma} = \sum_{i=1}^{m} \lambda_i \cdot N_i .$$ (7)

2. Estimation of warranty obligations cost in case of differences in warranty periods of a product's components

Now let us consider the second variant when the warranty period of a final product is longer than the warranty period of its component parts. In this case the expected cost of repairs during the warranty period is defined by formula (8):

$$C_{\text{ГР} \, u3\partial} = \left[\sum_{i=1}^{m} C_{\text{ГР} i} \cdot (r_{\text{РАБ} i} + r_{\text{ХР} i}) \right] \cdot T_{\text{Г} \, u3\partial} + \left[\sum_{j=1}^{k} C_{\text{ГР} j} \cdot (r_{\text{РАБ} j} + r_{\text{ХР} j}) \right] \cdot (T_{\text{Г} \, u3\partial} - T_{\text{Г СЧ} \, no\kappa}),$$ (8)

where $C_{\text{ГР} j}$ (rubles) is the average cost of a single warranty repair (replacement) of the j-th purchased component part, which is defined by the expert method upon results of the operation of analogous items;

$T_{\text{Г СЧ} \, no\kappa}$ (years) is the warranty period (warranty service period) specified for a purchased component part;

$r_{\text{раб} j}$ and $r_{\text{хр} j}$ is the total number of the i-th locally produced item's failures expected for one year of warranty obligations during the operation and keeping of the item respectively.

The values of $r_{\text{раб} j}$ и $r_{\text{хр} j}$ are defined by formulas (9) и (10):

$$r_{\text{раб} j} = A \cdot N_j \cdot \lambda_j \cdot Q,$$ (9)

$$r_{\text{хр} j} = 0{,}02 \cdot A \cdot N_j \cdot \lambda_j \, (1 - Q),$$ (10)

where λ_j is the failure rate of the j-th locally produced item, which is defined by the technical conditions;
N_j is the number of purchased j-th component parts.

The percent correlation of $C_{\text{ГР изд}}$ to $C_{\text{ИЗГ изд}}$ is defined by formula (11):

$$\Delta(\%) = \frac{C_{\text{ГР изд}}}{C_{\text{ИЗГ изд}}} \cdot 100\%. \tag{11}$$

The example of calculation of the expected cost of the warranty service of an item

Task

To define the value of the expected cost of warranty repairs ($C_{\text{ГР изд}}$(rubles)) and the percent correlation between this cost and the production cost ($\Delta(\%)$), with the warranty period required by a customer being equal $T_{\text{Г изд}}$ = 1, 2, 3, 4 and 5 years.

Source data

The technical use coefficient Q = 0.47 (according to specification requirements);
The average production cost $C_{\text{ИЗГ изд}}$ = 8632678 rubles;
The average production cost of a locally produced component part equals to 24317 rubles;
All the components of the item are locally produced.

Calculation

Using formula (7), we define $\lambda_{\Sigma} = \sum\limits_{i=1}^{m} \lambda_i \cdot N_i = 2458.3864 \cdot 10^{-6}$, where the values λ_i and N_i are defined by calculation of the reliability of an item.

Using formulas (5) and (6), we calculate

$$r_{\text{раб.}} = A \cdot \lambda_{\Sigma} \cdot Q = 8760 \cdot 2458{,}3864 \cdot 10^{-6} \cdot 0{,}47 \approx 11$$

$$r_{\text{хр}} = 0{,}02 \cdot A \cdot \lambda_{\Sigma} \cdot (1\text{-}Q) = 0{,}02 \cdot 8760 \cdot 2458{,}3864 \cdot 10^{-6} \cdot (1 - 0{,}47) \approx 1$$

The value of $C_{\text{ГР}}$ is defined by the expert method as the half of the average production cost of an item's single locally produced component part:

$$C_{\text{ГР}} = 24317 \text{ rubles.} \cdot 0{,}5 \approx 12160 \text{ rubles.}$$

The values of $C_{\text{ГР изд}}$ and $\Delta(\%)$ are defined by formulas (4) and (11) respectively

$$C_{\text{ГР изд}} = C_{\text{ГР}} \cdot (r_{\text{РАБ}} + r_{\text{ХР}}) \cdot T_{\text{Г изд}} = 12160 \cdot T_{\text{Г}} \cdot (11 + 1) = 145920 \, T_{\text{Г}}$$

$$\Delta(\%) = \frac{C_{\text{ГР изд}}}{C_{\text{ИЗГ изд}}} \cdot 100\% = \frac{145920 \cdot T_{\text{Г}}}{8632678} \cdot 100\%.$$

The values $C_{\text{ГР изд}}$ and $\Delta(\%)$ calculated for $T_{\text{Г изд}}$ = 1, 2, 3, 4 and 5 years are shown in Table 1:

Table 1

Given values of $T_{Г изд}$	Calculated values	
	$C_{ГР изд}$ (rubles)	$\Delta(\%)$
1 year	145920	1,69
2 years	291840	3,38
3 years	437760	5,07
4 years	583680	6,76
5 years	729600	8,45

3. Warranty service in terms of tax legislation

After having estimated the expected cost of warranty repairs, we can summarize that the fulfilment of these obligations upon delivery of a product to the customer can cause significant material costs.

In order to decrease these costs and to save money on profit tax, the producer is in his right to establish a money reserve fund for warranty repairs. This right is stipulated by Item 1 of Article 267 "Costs of establishment of reserves for warranty maintenance and repairs" of the Russian Federation Tax Code, as well as, according to Item 2.13 of Article 149 "Free-of-tax operations", no taxes are imposed on warranty services realized without extra payment related to maintenance and repairs of products during their warranty period, including the cost of spare parts and components for them.

The rules of establishment of a reserve fund are specified by Item 3 of Article of the Russian Federation Tax Code. Warranty costs are defined as allowances for reserve at the date of the sale of products by a manufacturer. The size of allowances cannot exceed the limit defined as the percentage of expenditures actually made by a taxpayer for warranty repairs and maintenance in the amount of revenues over the previous three years multiplied by the total sales revenue for the reporting (tax) period.

In case the taxpayer sells his products for less than three years with warranty provisions, the amount of revenues over the period of actual sales should be taken into account to estimate the limit of the reserve.

The taxpayer who has not previously sold his products with warranty repair services included is free to establish a warranty reserve fund in the amount not exceeding the expected costs for warranty maintenance and repairs.

Also, the warranty reserve fund which is not fully used by the taxpayer during the tax period for warranty maintenance and repairs of a product manufactured by him with the provision of warranty can be transferred to the following tax year. [4].

Conclusion

The method offered provides the possibility:

- To determine the expected cost of repairs (company's costs) during the warranty period and the correlation between this number and the manufacturing cost;

- To reasonably build funds for warranty service in the structure of the price and, in the first place, to do it according to the duration of the warranty period;

- After estimating the expected cost of warranty repair, to help to establish the reserve fund for warranty maintenance free from tax on profit.

References

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