# RELIABILITY OF LABEL FOR PROTOTYPES

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**Abstract**

This paper presents results of tests done in one of the prototype centre of automotive company. The researchers focused on reliability of labelling made of label printer. At the beginning of the article it has been hypothesized that there is a need of protecting of label printed in prototype shop because of damage possibility during transportation between operating stands. Authors try to justify the hypothesis using the results of case study. The summary of these studies ware used to increase satisfaction of plant management and customer. Recommendations prepared based on the analysis are focused on improving of the visibility of letters on the label.

**Keywords:** Prototype, labelling, visibility

## 1. INTRODUCTION

Most of companies optimize their activities and modernizes paths of project development. During prototyping process there is no special requirements for labelling or marking. Supplier has a lot of possibilities and can chose the type of component marking. Today's trends shows that reliability of the prototypes is needed and it is good if durability is confirmed by ageing tests. Described situation is forced by short timing dedicated to design the new solution. This trend is typical for automotive market. Reliability tests of prototypes have become the standard in product development path. That's why cheap and fast marking method needs to be validated [1, 2].

## 2. LABELLING FOR PROTOTYPES

Authors tested two types of labels. Paper label currently used for prototypes for internal information only and thermal printed labels made of plastic material which used to be send to customers. Both labels are self-adhesive and manufactured from commercially available materials and can be glued to different plastic components. Today produced labels used for tests are environmentally friendly [3]. Both types of labels were tested under the same conditions using climatic chambers and specified mediums. Researchers postulate that using paper label in selected conditions it can be observed that the information on paper are visible after ageing process and for prototyping it is enough to use this kind of labelling. From company point of view the prototype component has one main role: have to withstand operating conditions during assembling process plus withstand some basic functional tests. This approach has changed when engineering department began a durability tests on proto parts. Currently in automotive market the main type of marking of plastic components is a hard marking because is durable and easy to read even after hard tests simulating road conditions. General information included on hard marking are: a type of material and logo of supplier. But there is a group of information which is changing after every production run like date of prototype building or a component revision number. Hard marking is dedicated to share an information which are constant but in case of markings which are changing the laser marking or labelling is an easier way. Laser marking can be programmed on machine or label can be printed with different text or barcode. On prototype stage of the project printed text is used more often than barcode. This second solution requires dedicated equipment to read and encode the symbols. Prototype Centre does not have any process which can decodes barcode and that is why a big impact on that

decision have costs and a complexity of printed solution. The management sees cost saving and orders extensive testing of this solution [4]. The goal is to find the compromise between easy marking preparation and read versus costs of the marking. That means no additional equipment to encode and easy solution for printing is needed. In parallel marking for prototypes has to withstand some ageing tests or high temperature production process which are described in the article [5, 6]. At the beginning the researchers analysed which technologies do not generate additional costs on start of project implementation. Management requires a solution which is flexible and give a possibility to easy change marked text. Hard marking is rejected because of complicated way for text changes during process. For example the production date can be changed on hard marking when designer will use stamps (clocks) which can be updated to new settings. But this solution require intervention in meld tool. The similar topic was taken by engineers and scientists working on automotive market. One of the well-known by automotive engineers type of the marking is vibration assisted face milling (VAFM) enabling the placement any kind of information on the product surface. The technology is using a piezoelectric milling tool. The milling process is really quick but require dedicated equipment. The process can be used on many type of housing materials for example plastics, steel, aluminium alloy and titanium alloy [7]. But described solution requires special machine what generates additional costs. Competitive way of fast marking giving the same possibilities is laser marking. This type of marking offers the most opportunities for plastic components. Laser marking can be used for some other materials but requires special equipment what generate high costs. This type of marking can be used by plastic manufacturers and companies which are building products with plastic body. Laser marking is giving a possibility to illustrate company logo with high quality [8, 9]. Advantage of both of these methods is ability to make changes in the marking via computer program without changing the settings on the machine. For example operator can pick up the revision of the product if any kind of design change is implemented on final product. Second important point is production date which can be changed automatically. This kind of automatic changes is impossible when hard marking is used. This type of marking requires exchange of the stamp in meld tool what is time consuming. Yet another type of the marking is label printing which is easy to implement and the costs of implementing are 60% lower than other. Additional advantage is a possibility of using colour paper to highlight product of special care. Typically the printers use one colour for printing and it is why colorized paper is liked by operators on the production line, logistic department, model shop or on plant [10]. It is no matter what type of labelling will be used - all information must be readable. That is not important whether this is prototype or production part in case of specific material which have to be disposed carefully. This kind of information is very important for people handling the component [1, 11]. For production phase the labelling has to be automatically read and that is why laser sensing or optical technology may be used. On production line bar code is very helpful because gives a possibility of quick check of the component and verify in the system [12]. In case of prototype area the automatic system cannot be used. That is the reason why the authors are going to test two types of printed labels (no barcode) and check whether the labels are readable after durability tests. The production path and possible failures of label during production are also taken into account. The best solution will be recommended to prototyping centre for marking.

## 3. DURABILITY TEST PLAN FOR LABEL

Researchers prepared test matrix which included two main paths. First was linked to production path and second included parts of durability path for product. In production path two main types of test were described: mechanical and thermal tests (**Table 1**). This kind of tests were linked with conditioning in high temperature during potting process. The polyurethane resin required holding a few hours in specified by Material Specification Data Sheet temperature and the label which was glued on prototype component had to withstand this conditions too.

**Table 1** Test matrix

| Group of test | Test name | Label part number |
|---|---|---|
| Tests simulates possible production process impact | Temperature storage (a) | UST/16/1101 - UST/16/1106 |
| | Mechanical attrition (b) | UST/16/1101 - UST/16/1106 |
| Main durability tests | Temperature alternation test (a) | UST/16/1107 - UST/16/1112 |
| | Stone impact (b) | UST/16/1107 - UST/16/1112 |
| | Fluid impact | UST/16/1113 - UST/16/1148 |
| | Salt spray test | UST/16/1149 - UST/16/1155 |

The test sequence was scheduled according to automotive specification one of the general automotive company in Europe. Base on that temperature test (a) had to be prepared before mechanical impact test (b). In presented above table the sequence is visible for both test groups. Fluid impact and salt spray test are single test and are not linked to any other. That means in this case any other extra pretesting was not required by customers. The singular test or test sequence was made on 6 pieces of label as described in column 3 of **Table 1**. Set of labels for testing included two types of row material: three paper labels and three thermal printed labels. The media used for tests were common for a few customers and the test results are universal. All fluids were taken from test handbooks from customers and specification is common for all of them. Media used for tests are fuel, AdBlue®, engine oil, water, coolant, glass cleaner. The results are going to be assessed for example by percent of label destruction (letters), change of the paper colour, contrast of letters to background, and label adhesion to component. The label was covered by letters on almost whole surface which gave a possibility to count the number of unreadable letters after durability testing (**Figure 1**).

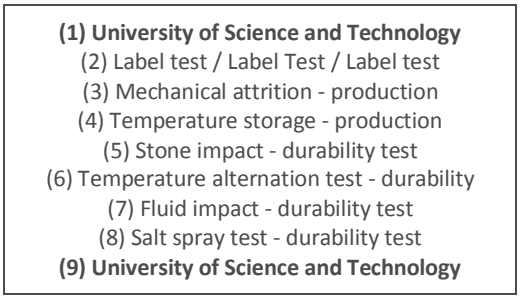


**Figure 1** Design of the label

Letters used on label were the minimum font size (font size 9) specified by customer. Authors were going to test the worst case. That allowed to put nine lines of text on the label during experiment [13, 14, 15].

## 4. TESTING

Described in article labelling type was glued on plastic prototypes made of polyamide with glass fibre (33% of glass fibre) as the only one material used for product line. Before placing of the label on the peace of plastic component the surface was manually cleaned and checked against dust and inequalities. Primer was not used for surface degreasing during experiment because it is not standard approach in prototype centre. During prototype building no cleaning fluids were used. From project point of view it was controlled that the label has to be glued on surface where was no parting lines after injecting process or no depression points after stamps. Location was specially selected by engineer and recommended to label gluing. To cover above described conditions a plastic prototype parts were used for testing. At first the tests simulating possible production process impact were run in order to test matrix. The prototypes during production in model-shop centre were

stored in climatic chamber by 4 hours at 80°C for conditioning of a potting resin. At the beginning of prototyping process the label was glued on the main body to sign the part and control a process flow step by step. In this case label had to withstand the same conditions as component and had to be readable after finalizing of the build. After temperature storage the mechanical destruction could happen on production line for example during machining or welding process. Temperature impact was unknown and may have made mechanical destruction easier to happen. The test was done on three paper labels and three thermal printed labels and the results were similar for both. Thermal ageing in constant temperature did not destroy the letters and a row material as visible on **Figure 2**. Only the contrast on label was a little different than on virgin part but this result did not discriminate paper raw material to use in prototype centre. Each letter (294 out of 294) on every label (6 out of 6) was readable and hole labels were accepted after testing. Retention force of aged label was also accepted. The measurement system was specially designed and consisted of holder dedicated to label keeping and measurement electrical device [16]. This solution can be recommended for prototype centre as a proper type of prototype signature. Even if the labels withstand production conditions the durability test which the customer is going to prepare may fail the paper and make the letters unreadable. After sending of the parts to the customer the producer lose control on parts and has to commit to status of the parts (functionality and durability). Before shipping a supplier can check the quality and exchange the label in case of any issue. Further the component is strongly operated by customer and marking has to be visible after basic durability test. That is the reason why the authors run second part of test matrix to confirm labelling reliability. In first step the temperature alternation test was done with temperature profile from -40°C to +100°C. Temperature migration takes 5 hours and holding time in max and min temperatures is 1 hour. Profile takes 12 hours in total and 30 cycles were done. In second step stone impact test was performed after temperature alternation test with an interval of one day between tests. Stone impact test was done according to the most restrictive customer specification which were intentionally selected. When the set of tests was finished the labels were assessed vie criteria described at the beginning of the article. Temperature alternation test was done before stone impact test and the results were positive after this set of tests as presents **Figure 3**. Both type of labels were readable and, change of contrast was not detectable by human eye (application of any other digital method was not necessary).

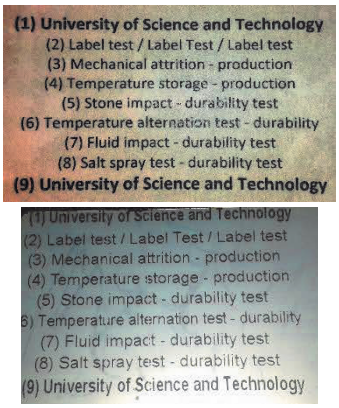


**Figure 2** Labels after simulation of production conditions test (left: paper, right: thermal printed)

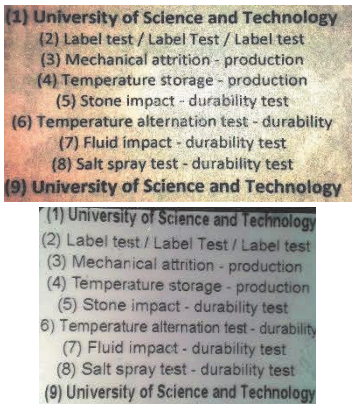


**Figure 3** Labels after durability test (temperature alternation and stone impact)

Low temperatures did not have any impact on labels and the visibility of letters was correct. Retention force decreased maximum 18% versus virgin labels what was acceptable. Stone impact test results were not positive on standard paper label: 289 out of 294 letters were fully visible but it was not enough to be text readable. The failure which may happen when two adjacent letters (one after another) were scuffed what could provide to a situation the production date or part number were unreadable ant that cannot be accepted by operators (engineers and people working on production line of prototype). Short part number and production date were

main information on label which have to be visible during whole live time of component. Thermal printed label does not share any defect of letters which makes them unreadable. Last two test were chemical impact tests and it should have been prepared on separated samples. Both types of label (three part of each) were under 1 hour exposure of medium. Six different mediums were used and the test was performed in room temperature (**Figure 4** and **Figure 5**). All liquids were painted on label twice with one minute interval. Standard brush was used for this operation.

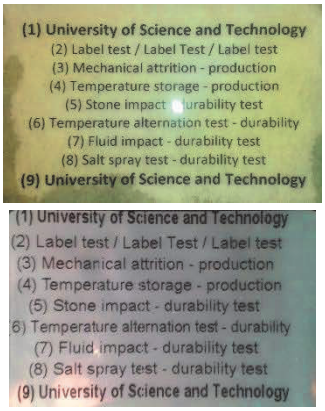


**Figure 4** Fluid impact - oil

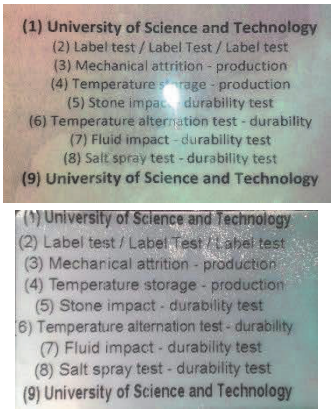


**Figure 5** Fluid impact - coolant

This kind of fluid application on whole label simulates inundation of the label. Retention force test is not applicable in case of paper label because material is damaged. Only thermal printed labels can be checked and the results are changed maximum 11% versus virgin samples. Last one test: Salt spray test was a specific ageing process which allow to check leak and reliability of connections like O-Ring or potting adhesive. Salt spray test is dedicated to the group of products which are exposed on snow or rain. Labelling has to withstand this kind of impact too. The test was done in salt spray chamber according to automotive specification. The results showed that paper label cannot be used for this kind of application versus thermal printed labels which are excellent under salt conditions. The letters after cleaning of the label are fully visible and all information are readable. Marking on paper is polluted and during cleaning whole text was destroyed. The results of the test are shown on **Figure 6** [14, 17, 18, 19].

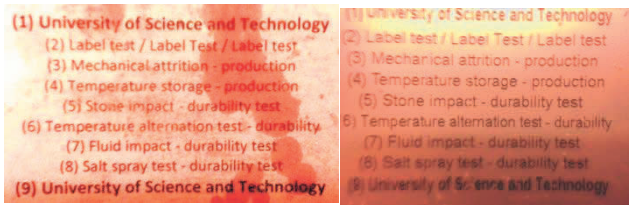


**Figure 6** Salt spray test

## 5. CONCLUSIONS

Both types of labelling can be applied to the dedicated application if ageing tests are not applied. Other way the only what needs to be checked are conditions which have to be covered by raw material of label. Conducted tests shows that paper label cannot be under chemical impact at all. Moreover mechanical impact can makes them unreadable. But it does not mean the applications where paper label can be used does not exists. Researchers propose to use the paper labelling for electronic applications where chemical testing is not used and the possibility of stone impact does not exists. That approach generate 62% cost saving. In one of automotive company located in Krakow 4170 prototypes were built during 2015 year. 1807 of them were electronic devices located under car dashboard or inside the passenger compartment. This allow to use paper

label which is four times cheaper than thermal printed label. Other prototype components are located in engine compartment or under vehicle where marking has to be resistant against specific fluids, stone impact and salt may be built with use thermal printed label. This kind of cost saving in one division of company is an added value and every one department may introduce this kind of approach makes the product more green and scale effect will bring cost saving on higher level [3, 4, 19, 20, 21].

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