

QR Code Label Testing



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Overview

Technology: Connected Worker

Business Capability: Augmented Reality Delivery Mechanisms

Background

A significant portion of the Digital Manufacturing strategy is to enable further access to digital content from diverse locations. With the express intent of producing safer and more efficient operations, Quick Response (QR) codes are a method of providing on-demand access to data in the field right next to the physical manufacturing equipment. The desire is that through a single code scan, users can quickly reference the oil settings, equipment master-files, Process and Instrument Diagrams, spare parts, NLI/LI learnings from past Job Loss Assessments (JLAs), etc in the field while they were about to complete a task. One barrier to implementing these codes in the field is the harsh plant environment which can cause degradation on the physical labels containing the codes. Before QR codes can effectively open the door to on-demand data access, a reliable label medium needed to be identified.

Solutions Reviewed

Avery Weather-Proof Chemical Labels: Waterproof adhesive labels resistant to chemicals, abrasion, UV and extreme temperatures.

Avery Acrylic Adhesive Magnet Labels: Durable waterproof magnetic labels designed to adhere to all metallic surfaces.

Zebra Thermal Printed Z-Supreme Labels: Ultra-durable labels designed to withstand diverse weather conditions and extreme temperatures.

CamCode CMMS MetalPhoto Aluminum Labels: Ultra-durable labels, laser-thermal printed, on aluminum tags.

Acceptance Criteria

As each solution was evaluated, the following acceptance criteria were used to determine whether the proposed solution could be considered as a viable candidate for use within ExxonMobil. The objective of the testing was to determine a reasonable recommendation for reliable labeling solutions in industrial manufacturing and outdoor areas. All evaluations of the proposed solutions were done in multiple, separate environments against these specific constant criteria:

Cost per Label

Need for Special Equipment

Label Ink Fade

Label Peeling

Label Adhesion

Discoloration

Installation/Removal Difficulty

Solution Evaluation

As each solution was evaluated for viability, **the Zebra Z-Supreme labels were eliminated** prior to initiating the endurance tests due to the fact that the labels require a specialized printer to be purchased and connected to the field users' computers via USB before they could connect and print any of their labels. At ~\$1600 per printer, this technology was determined not worth the cost given the low volume of labels that each site would ideally print.

The remaining solutions were installed in several different locations to test their endurance in real-life service over a prolonged period of time. QR codes were printed on a sample label from each solution and installed at two separate locations: the Mont Belvieu Plastics Plant in Mont Belvieu, TX, and the ExxonMobil Campus location in Spring, TX.



Endurance Testing

Testing Methods

Representative labels from each of the three potential solutions, Avery Weather-Proof Chemical Labels, Avery Acrylic Adhesive Magnet labels, and CamCode CMMS MetalPhoto Aluminum Labels, were all printed with an identical QR code linked to a **Qdash QR Code Dashboard***.

Within the Mont Belvieu Chemical plant, one of each of the three label samples were placed on an electrical cabinet adjacent to one of the site boilers for the plastics extruding unit. This electrical cabinet was specifically selected to test the labels in direct exposure to sunlight and ambient weather as well as radiant heat from the nearby operating equipment. The labels were installed at Mont Belvieu on **December 16th, 2019** and remained in service until **February 16th, 2020** or until failure (loss of adhesion to surface being primary failure mode) was determined.

At the Spring, TX location, the test set of labels was placed atop an outdoor parking garage – an outdoor location with direct exposure to sunlight and environmental elements. These labels were installed on **December 9th, 2019** and are designed to serve as the long-term specimen-set and will remain in service until failure is determined.

Defined Test Criteria

All labels installed at the Mont Belvieu location were left in place for a pre-set period of 60 days. At the end of that period, all label solutions were ranked on their performance in the following categories:

- Ink Fade - **20 pts**
- Label Adhesion - **20 pts**
- Discoloration - **20 pts**
- Installation/Removal Difficulty - **20 pts**
- Cost - **20 pts**





A total of 100 points were available for label solution across the given categories. A comparison matrix was compiled to rank each solution based on the amount of points scored in each category. This matrix and the results of the tests are detailed in a later section of this bulletin. All labels installed at the Spring location will be left in place indefinitely and checked for failure on frequency of no less than once every two weeks. Labels will be deemed failed if adhesion fails or if print on the label surface becomes unusable due to element exposure.



Endurance Testing Results

As indicated previously, all labels tested in the Mont Belvieu location were simultaneously reviewed against the specified criteria – each with an equal weight of points. A total of 100 points were available for each label solution across the given categories, and **each solution was given a certain number or points based on how the solution performed relative to its peers**. The ranking process was a forced ranking where each category must have a solution scoring in the top third, middle, and bottom third of the specified points scheme (i.e. no two solutions can score the same on the same category).

As points were assigned to the separate solutions, a comparison matrix was subsequently compiled to rank each solution based on the amount of points scored in each category. The detailed matrix and detailed discussion of the results are indicated below:

<u>Solution</u>	Ink Fade	Label Adhesion	Discoloration	Installation/Removal Difficulty	Cost	Total:	Determination
 Zebra Thermal Printed Z-Supreme Labels	NA	NA	NA	NA	0	0	NFFP
 Avery Acrylic Adhesive Magnet labels	18	0	18	20	18	74	NFFP
 Avery Weather-Proof Chemical Labels	15	18	15	18	20	86	FFP w/c
 CamCode CMMS MetalPhoto Aluminum Labels	20	20	20	15	15	90	FFP



Endurance Testing Results - Zebra

1.5" x 3" Z-Xtreme 400T Labels (Plain)



Zebra Thermal Printed Z-Supreme Labels

Summary: Solution was ruled out prior to the beginning of the endurance testing.

Solution was deemed Not Fit For Purpose (NFFP) due to the fact that the labels require the additional purchase of a specialized printer. This printer would subsequently require users to connect via USB to their GME computers and install a specialized printing software before they could connect and print any of their labels.

Description: Synthetic Polypropylene label material type. Thermal Transfer printing technology. Key features include excellent fade and harsh chemical resistance. Industrial adhesive backing includes synthetic offering with rubber – making it ideal for plastic and metallic surfaces. Labels can be purchased in rolls and printed via Zebra proprietary Thermal Printers which also must be purchased for use.

Spec Sheets:

[Z-Xtreme 4000T Matte – High-Performance Permanent Adhesive](#)

[Z-Xtreme 4000T Matte – High-Tack Rubber Adhesive](#)



Endurance Testing Results – Avery Magnetic Labels

1.5" x 0.50" Magnetic labels



Avery Acrylic Adhesive Magnet labels

Summary: Solution was ruled out approximately halfway through the endurance testing. **Solution was deemed Not Fit For Purpose (NFFP)** due to the fact that the test label at the Spring Campus location lost adhesion approximately 30 days after initial application. The magnetic labels were placed on an electrical cabinet at Mont Belvieu Plastics Plant and a Traffic sign at the Spring Campus. While the type of metallic surface utilized for the magnet does play a significant factor on the level of adhesion, this variability in the label's performance between the two sites led to the NFFP decision. Because this label was unable to last the full length of the test, it was given the lowest scores on all categories except for ease of installation/removal. Because of the magnetic backing on these labels, the tags could easily be removed and reused without any need to destroy and recreate the label.

Description: A combination of Avery's UltraDuty® GHS Chemical Labels attached to low-profile magnets via a permanent adhesive, the Acrylic Magnet Labels are designed to be waterproof, UV resistant, and compatible with most metallic surfaces. These magnetic labels have the magnet on one side and the printable label on the other; the profile is low enough that the labels are laser-printer compatible. Procurement is just as easy as other Avery products. Sheets of Avery Chemical Grade Labels can be purchased with P-Card directly from [the Avery website](#) or through Amazon.

Spec Sheets:
[BS5609 Sec. 3 certified](#)





Endurance Testing Results – Avery Chemical Labels

2" x 4" GHS Chemical labels



Avery Weather-Proof Chemical Labels



Summary: Labels maintained good adhesion throughout the length of the tests and demonstrated minimal ink fade or discoloration. **Solution was deemed Fit For Purpose with Caveats (FFP w/C).** While all labels maintained good adhesion throughout the test, the sticker labels proved to be susceptible to abrasions and slow ink fade over time. At the end of the testing period, all codes were still scannable, but expected life of the *labels should not be expected to last longer than 1-2 years* depending on service environment and level of exposure to elements and abrasions. This label scored slightly lower in ink fade/discoloration but did score higher on ease of installation/removal; while the adhesive used is permanent, the ease of printing new codes make the process of installation much easier as code labels can be destroyed and replaced without significant loss.

Description: Avery® UltraDuty® GHS Chemical Labels equipped with permanent adhesive are designed to be waterproof and UV resistant. Label adhesive is intended to last despite extreme temperatures (as low as 10 DegF) and labels have been tested to remain adhered at least 90 days in seawater. **Avery labels are laser-printer compatible**, so procurement is easiest among all labels solutions reviewed. Sheets of Avery Chemical Grade Labels can be purchased with P-Card directly from [the Avery website](https://www.avery.com) or through Amazon.

Spec Sheets:
[BS5609 Sec. 3 certified](#)



Endurance Testing Results - CamCode

1.5" x 0.50" 0.020" Metalphoto Asset Labels (Plain)



CamCode CMMS MetalPhoto Aluminum Labels



Summary: The most durable solution tested, **Solution was deemed Fit For Purpose (FFP)** given the label's excellent performance in resisting environment exposure and elevated heat levels. The label tags experienced no loss in print quality or adhesion and demonstrated the best quality-over-time compared to all solutions reviewed. The CamCode label scored lower in installation/removal difficulty because the adhesive was so strong that extra care was needed to ensure the label was properly placed; once adhered, removal was nearly impossible without destroying the tag.

Description: CamCode MetalPhoto aluminum labels are constructed of .020" anodized aluminum face stock with various thickness options depending on the user's usecase. Camcode provides multiple levels of high-performance permanent pressure-sensitive adhesives and/or holes for mechanical attachment. Adhesives are designed to permanently bond to high surface energy metals and plastics, and are compatible with both textured and contoured surfaces. Tags have excellent resistance to chemicals, abrasion, and solvents, and, depending on the adhesive used, will withstand exterior exposure in the harshest environments, including extreme cold, heat and UV. Labels can be procured [directly from CamCode](#) via purchase with P-card or standard PO. A pdf design of the label and .CSV spreadsheet are needed to detail to the vendor what the tags should look like and what content should be included; CamCode will then ship the purchased tags as requested.

Spec Sheets:

[Metalphoto Product Sheet](#)

[Metalphoto Spec Sheet](#)