QUALITY CONTROL METHODS AND INDUSTRIAL APPLICATIONS

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Abstract: Paper presents four control methods widely used in quality control in industry and their applications. The three methods analyzed in this work are optical-visual control, control with penetrating liquids, control with magnetic powders and measuring the thickness of paint layers. To exemplify them, several images are presented that emphasize their practical importance in the case of several parts made by plastic deformation or by welding. The work can fit very well into the research regarding the current state of the application of the control methods used successfully in the industry.
Key words: control, optic, electromagnetic field, penetrating liquids

1. QUALITY CONTROL METHODS

1.1 Generalityes

The non-destructive control of the quality of materials consists of several methods and techniques that have the role of evaluating the structural integrity of semi-finished products, parts or devices, without affecting their functionality or usefulness. This type of non-destructive control is an integral part of most stages of parts production processes, with the main objectives of ensuring product reliability, avoiding defects, preventing accidents and, of course, increasing profits. At the same time, the non-destructive control methods are also used in the periodical controls of various parts or equipment in operation, for the evaluation of their structural integrity and the degree of safety in operation.

In industry there are several important components of quality control that are presented in the following [1]:

- inspection – that usually means regularly examining products, materials, or services to identify defects, non-compliance, or deviations from quality standards;
- testing – that consists in conducting various tests and measurements to assess the performance, functionality, or characteristics of parts or service;
- statistical process control - that means employing statistical techniques to monitor and control the production processes;
- documentation and records – that consists mainly in keeping detailed records of inspections, tests, and corrective actions taken to maintain traceability and accountability.
- corrective action - implementing appropriate measures to address any identified quality issues and prevent their recurrence.
- training and education - that ensures employees with the necessary skills and knowledge to maintain quality standards effectively.

- continuous improvement – that leads to constantly analyzing data and feedback to identify areas for improvement and enhancing the overall quality management system.

1.2 Visual optic control

Visual inspection is, by far, the most widely used non-destructive inspection technique, being an integral part of the vast majority of other non-destructive inspection techniques. One of the definitions of this type of control says that this is the process of examining and evaluating systems and components using the human sensory system: sight, hearing, smell, touch [2]. The physical phenomenon on the basis of which the optical-visual examination takes place is the reflection of light on the surface of the part to be examined. In order to perform a correct visual control, there must be an optimal distance of at least 600 mm (recommended 300 mm) from the surface to be examined and at an angle of approximately 30°. Examining surfaces at smaller angles can be compromised by possible shadows obscuring the presence of defects. The operator's visual acuity is an extremely important characteristic. It represents the ability of the eye to notice the smallest details or to differentiate their shape. In optimal lighting conditions, the normal eye has a visual acuity of 1 minute of arc (1/60 of a degree). Average visual acuity is 2 - 4'.

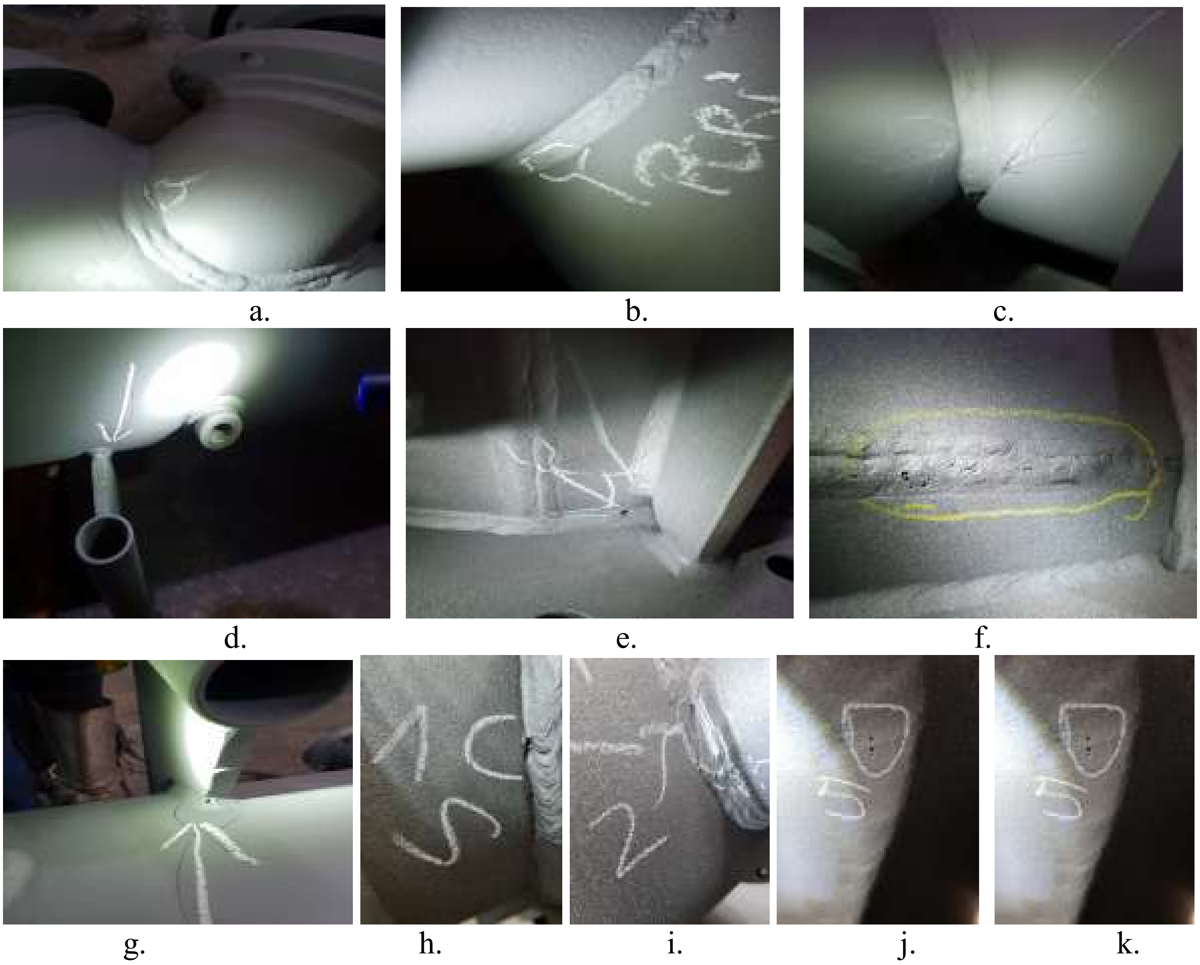
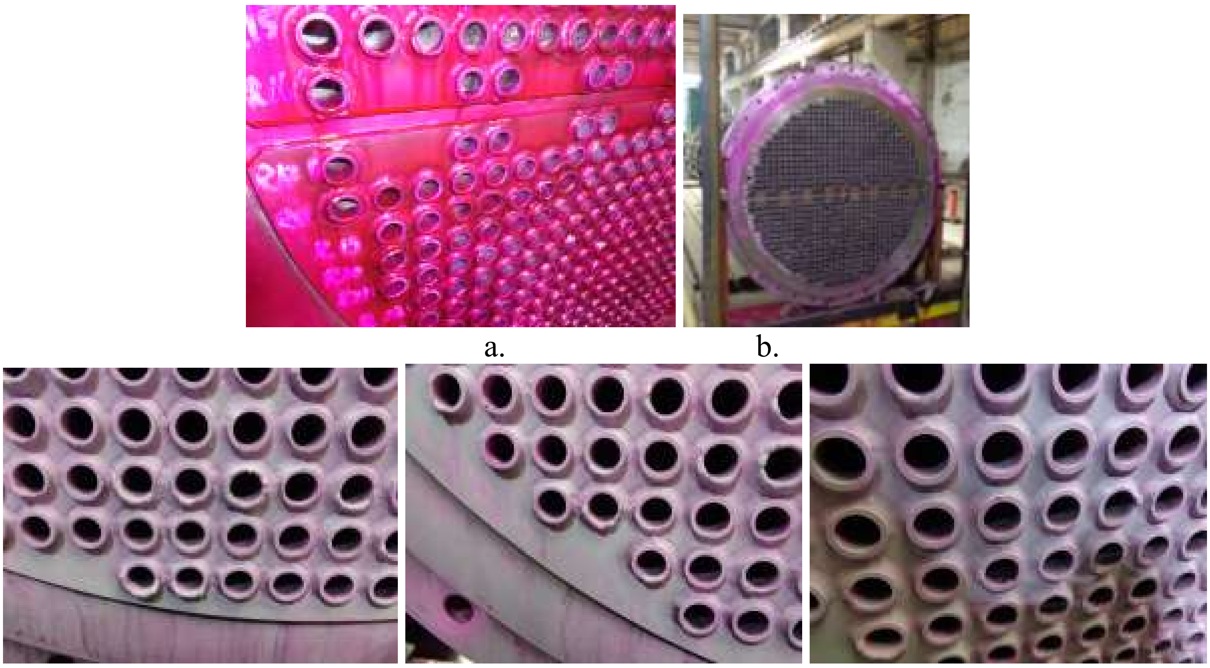


Figure 1. Visual optical control of welded joints

It is considered that the visual acuity of a person is within normal limits (with or without glasses), if he distinguishes defects of the type of cracks with openings of 0.07...0.15 mm, from a distance of 250 mm and under the conditions adequate lighting. The distance from which the surface is examined has a great influence on visual acuity. In general, the focus of the human eye is optimal for distances greater than 250 mm. For this reason, the recommended distance between the eyes and the examined surface should be 250 – 600 mm [1]. Using this control method, several images of surfaces controlled in this way are presented below.

1.2 Non-destructive testing with penetrating liquids

Liquid penetrant control is an easy-to-use, fast, relatively inexpensive technique, and as a result is a very used technique. The technique involves the application of a liquid (penetrant) on the surface to be examined, a liquid that will penetrate the imperfections of the surface. Observation of these fissures, voids and cracks is done with the help of a developer that extracts the penetrating liquid from the imperfections, visibly coloring in the area where there is a defect. The detection limit of this technique (minimum detectable surface discontinuity) can be determined to be approximately 2-3 μm [2]. Very often, this method of non-destructive control is also used in the inspection of welded joints.



a. b.

c. d. f.

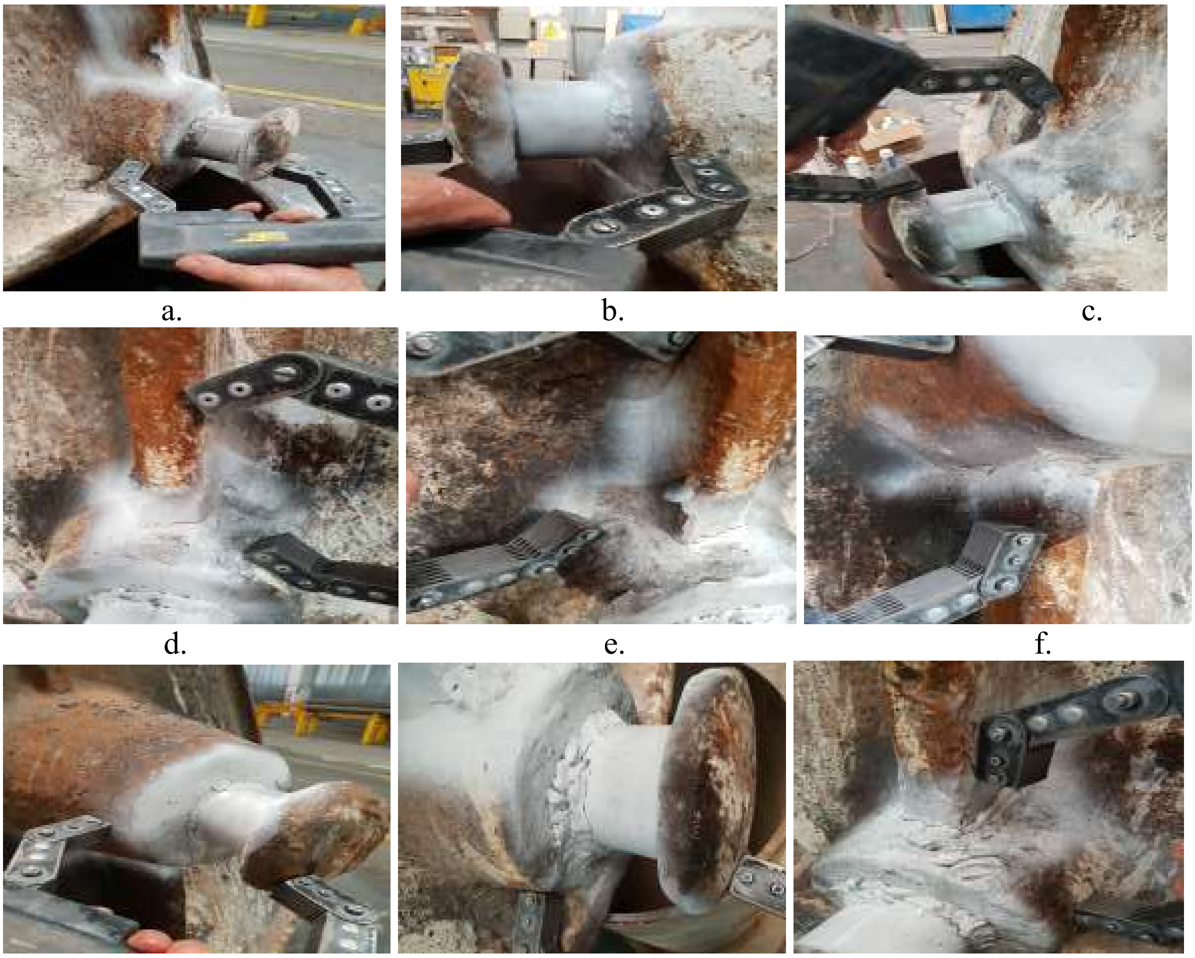
Figure 2. The use of non-destructive defectoscopy with penetrating liquids in welded seam control

In this sense, figure 2 presents the control with penetrating liquids of a heat exchanger, on the front side of it. Figures 2 a presents the application of the penetrating liquid on the front surface to control the welded joints between each pipe of the exchanger and the front plate on which they are fixed. Figure 2 b shows the application of the penetrating liquid on the surface of the outer flange of the front part where also the welding technique is applied.

Figure 2 c, d, and f presents the step of applying the developing liquid on the frontal surface to observe the probability of the appearance of defects, especially in the area of welded joints.

1.3 Non-destructive defectoscopy with magnetic powders

In principle, this technique consists in magnetizing the part under control and depositing a fine ferromagnetic powder on its surface. In the areas where there are defects, a dispersion magnetic field or leakage magnetic field will be formed, due to the fact that the magnetic field lines will bypass the defect, having to go outside the material of the part. In these areas, with leakage fields, the agglomeration of the ferromagnetic powders deposited on the surface of the part will be observed, which constitutes the indication of the respective defects. The physical phenomenon that allows the defect to be highlighted is the appearance of the dispersion field, in the area containing the defect, and not the fact that particles agglomerate in the area of the dispersion field. This technique can highlight only surface defects or defects in the immediate vicinity of the surface (3 – 5 mm) and can only be applied to ferromagnetic materials.



a. b. c.

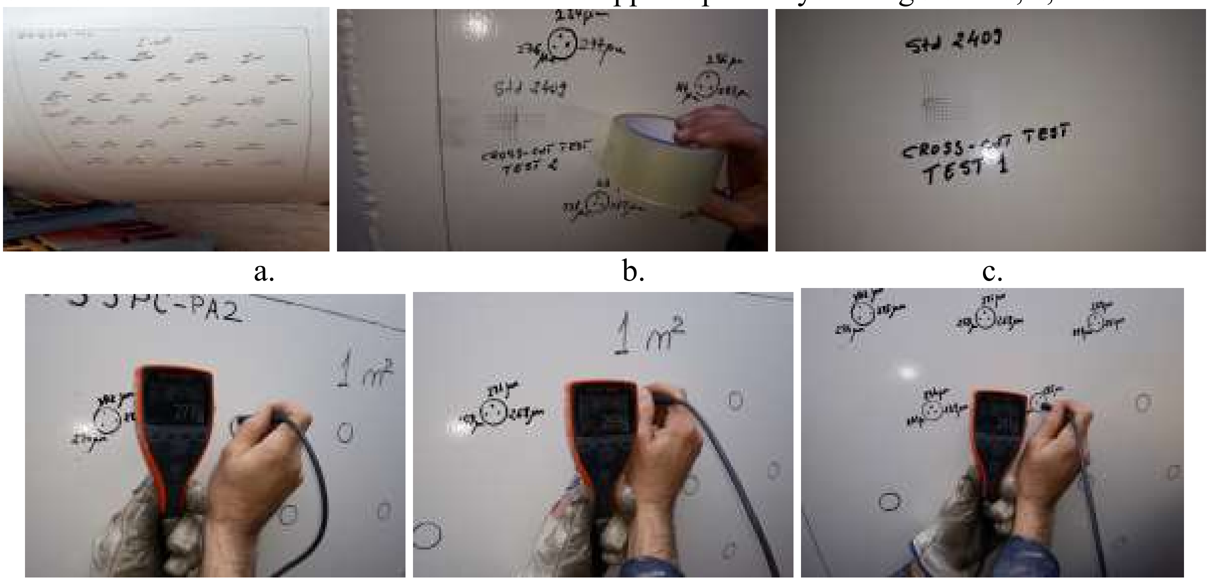
d. e. f.

g. h. j.

Figure 3. The use of defectoscopy with magnetic powders in order to control the welded joint areas in the case of a cylindrical container

1.3 Determining the thickness of paint layers

Determining the thickness of the paint layers is part of the control methods that can highlight the lifespan of the industrial parts,. generally metallic, since after a period of time the corrosion process becomes important and can affect the integrity of the structures. In such a way it is possible to constantly monitor coating deposition process and guarantee the thickness and thus the functionality of coatings. But not only that. In addition to monitoring the thickness and ensuring the quality of coating, it is possible to reduce process and material costs, comply with important industry standards and continuously keep an eye on corrosion process. Most parts in the industry are painted against corrosion but also from an aesthetic point of view. The control of the thickness of the paint layers is done using a device based, for example, on the propagation of ultrasound in materials. The control procedure can consist of setting up a work matrix where the measurement of the material layer will be carried out. Figure 4 a, b, and c presents the determination of the control points in order to realize different measurements of the thickness of the applied paint layer in figures 4 d, e, and f.



a. b. c.

d. e. f.

Figure 4 Measuring the thickness of the paint layer

2. MEASUREMENT AND CONTROL REPORT AND ESTABLISHING PRODUCT TRACEABILITY

Different kind of reports are used to report the results of the quality control of the parts, but especially of the welded joints, but also to achieve the traceability of the products in the industry. In this sense, figure 5 shows a snapshot of images from a control report made during the inspection of several welded seams. in this Excel format the columns represent:

- Line – welded seam shape
- Weldn – operation number
- Date - data
- Type – welding tehnology
- O – part diameter
- Welding part – the part of the assembly that is welded
- Thk – the thickness of the welded part
- Proced no. – procedure and reference standard

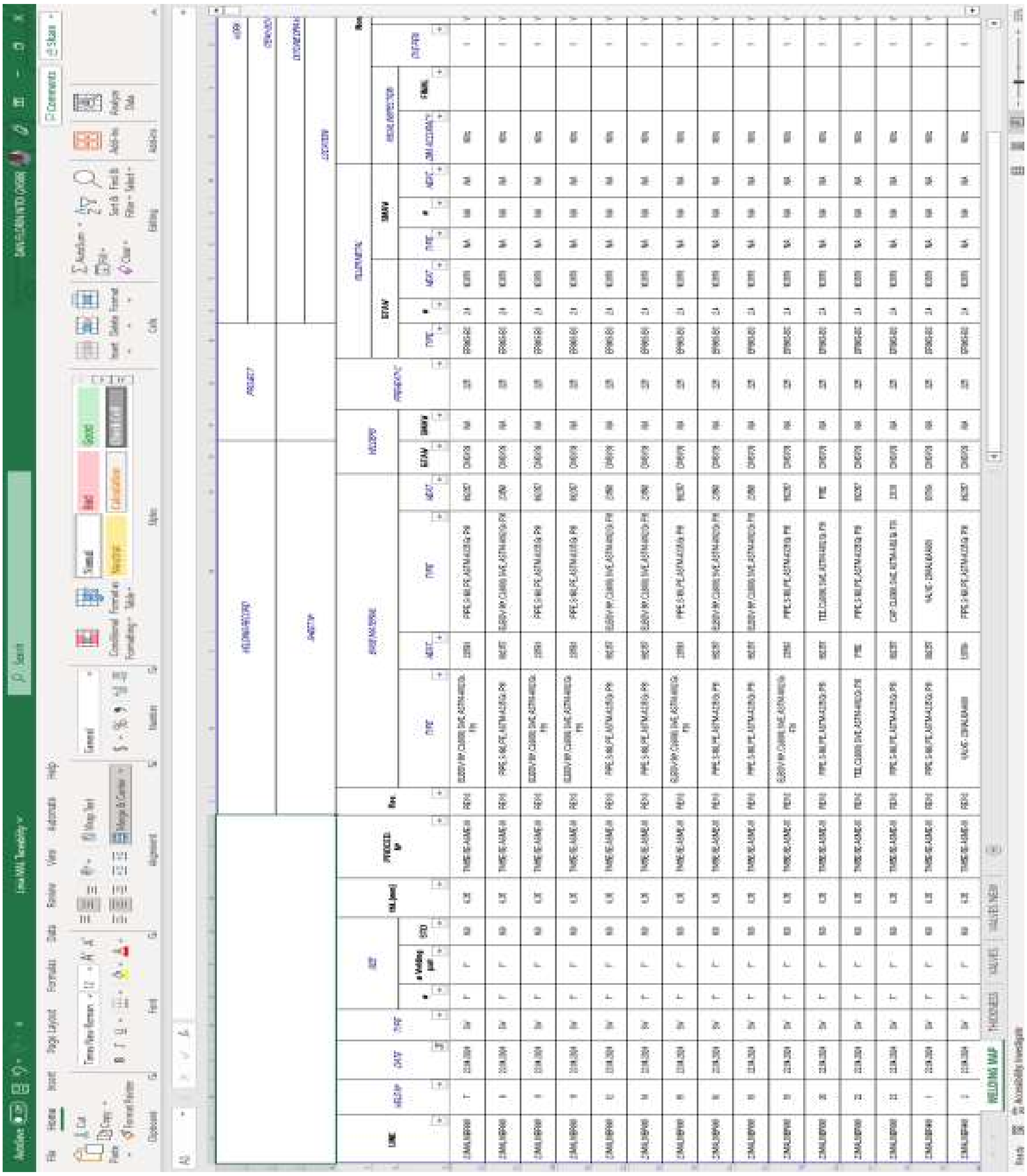


Figure 5. Excel format for quality control sheet

- Rev – revision no.
- Type – part type
- Heat – type of heat
- Ctaw – welding in a protective gas environment
- Smav – manual welding with coated electrode
- Dim accuracy – the percentage of the controlled surface
- MF – magnetic field control

- X-ray – x-ray control
- US – ultrasonic control
- Hardness test –hardness of the material
- Preheat – if there is preheating
- Heat treatment – thermal treatment

3. CONCLUSIONS

Quality control of parts and welded joints is a very important stage of all the procedures to which the production of a piece or a welded assembly is subjected.

The presented control methods are very well defined and offered in such a way that the beneficiary obtains a maximum of information about the quality of the piece that will be received.

Regarding the the control report presented, it contains all the necessary elements of the part identification, the type of welded cord, the control method and all the other important parameters of the welded assembly.

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