

Achieving zero-defect production in HVAC cable assembly

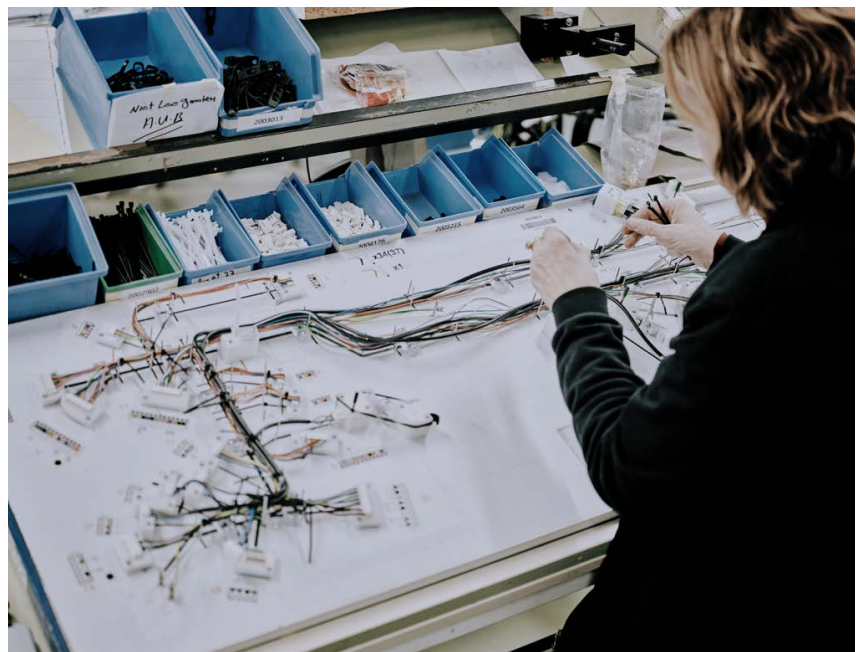
The HVAC market has become increasingly competitive and quality-driven. The products such as heat pumps, air conditioning systems, (heat recovery) ventilation systems have become more and more complex. In this context, zero-defect production has become the standard – not only to meet customer expectations but also to comply with today's stringent safety regulations.

As a long-standing supplier to major players in the HVAC industry, we understand that delivering premium-quality cables and cable harnesses requires more than technical know-how. It demands a quality culture of continuous improvement and a systematic approach to eliminating (potential) defects.

This article serves as a best-practice case, detailing our approach to achieving zero-defect cable assembly production by highlighting the key principles, challenges and solutions.

Zero-defect production

Strongly rooted in the First Time Right principle, zero-defect manufacturing is a quality management concept that focuses on preventing defects rather than detecting them after they have occurred. It aims to improve product and/or service quality, while reducing the costs associated with defects and waste. The ultimate goal of this philosophy is to create a production environment where defects are virtually non-existent, thereby minimizing waste, increasing efficiency, and consistently delivering high-quality to the customer.



Challenges in achieving zero-defect cable and wire harness production

The aim of zero-defect production is clear ; however, the path to achieving it is more complex. At WAAK, for the assembly of cables and wire harnesses, we have identified 3 major challenges:

1. Managing a complex manufacturing process

Cable and wire harness assembly involves a multitude of sequential steps - each of which must be executed correctly to avoid defects in the final product. In order to manage this complexity, WAAK has implemented the following measures:

Coherent process flow

Allows for highly accurate dimensions, with tolerances down to hundredths of a millimetre. However, this process is significantly more expensive than low-pressure moulding.

Workflow transparency

To make work less complex and to keep quality control at all times, we divide the production workflow into clearly defined operations. Each operation may contain several individual processes, all of which are documented with the following key information:

- Required tools and materials
- Workstation specifications
- Skill level of the operator
- Detailed process instructions

This structured approach ensures that we maintain an overview over the production flow at all times and that each step in the process is transparent and reproducible.

Visual Support

Finally, to further prevent errors, we make sure that each operator is provided with visual aids such as diagrams, photos, and instruction sheets. These tools offer the operator clear, step-by-step guidance.



2. Quality control in the production process

Through preventive measures, clear standards and continuous monitoring, quality control is at each step of the production process:

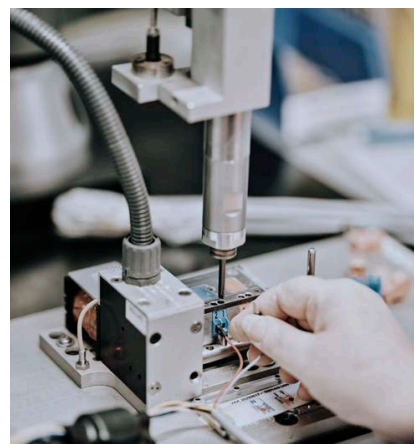
Inspection of incoming materials

To control all incoming materials used in the production process, we have defined a clear set of specifications that must be verified upon delivery. If the delivered materials meet these specifications, they are accepted and registered. If not, the supplier is notified, and the materials are quarantined in a designated warehouse.

Tool verification and release

Before a tool is deployed in our production environment, it is subjected to a controlled release procedure:

- Sample products are manufactured and verified against specifications.
- A release report is logged, and verified and released tools are visibly marked
- All tools are subjected to preventive maintenance to ensure consistent performance.



FMEA Control Plan

At the core of WAAK's quality strategy is the use of a Failure Mode and Effects Analysis (FMEA). This methodology helps us to:

- Identify potential failure modes in products and processes.
- Assess the causes and consequences of these failures.
- Prioritise actions to mitigate risks.

The results of the FMEA analysis feed directly into a detailed Control Plan, which specifies:

- Critical process parameters
- Inspection methods and frequency
- Specific actions to monitor and control quality

The FMEA analysis and control plan ensure that risks are proactively managed.

In-line quality control

Setting up standards is only one part of the solution; actively maintaining

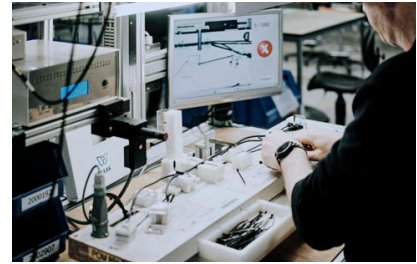
those standards is equally important. WAAK conducts regular in-line inspections during production. The results are logged and reviewed monthly. If quality issues become apparent through these findings, improvement actions are implemented.

Poka-Yoke

We integrate Poka-Yoke techniques in the cable assembly process to eliminate the possibility of human error:

- Physical constraints: Devices that prevent incorrect assembly, such as alignment pins.
- Automatic shut offs: Machines that stop automatically if an error is detected (e.g.: incorrect crimping).
- Alarms and alerts: Visual or audible indicators that notify operators of errors (e.g., a lock that will not open if something is wrong with the cable harness).

These mechanisms result in a more qualitative end product, with fewer errors, operational risks and waste.



3. Developing skills and knowledge

Finally, it is evident that the skills and know-how of your employees also play a crucial role in achieving zero-defect production. WAAK invests heavily in training and developing the skills of its employees (i.e. operators, quality personnel and developers). We evaluate their skill set per process on a regular basis. These findings are documented in an employability matrix. This ensures that the right person is assigned to the right task.

Here is an excellent example of how we have integrated a training program for our power cable employees into our supporting software.

Conclusion

Achieving zero-defect production is the result of a deliberate, structured, and disciplined approach. Quality must be seamlessly integrated into the production process and embedded within the company culture.

At WAAK, excellence in quality is achieved through rigorous quality control measures, a coherent and efficient production flow, continuous monitoring and the ongoing training of our workforce. This comprehensive approach ensures that each cable or wire harness leaving our facilities consistently meets the highest quality standards and requirements of our customers, thereby fostering long-term satisfaction and trust.



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