The 57th International October Conference on Mining and Metallurgy
05 - 07 October 2026, Bor Lake, Serbia
https://ioc.irmbor.co.rs

DOI: 10.5937/IOC26217K Original Scientific Paper- Materials Science

VERIFICATION OF METALLIC MATERIAL CERTIFICATION IN INDUSTRIAL SUPPLY CHAINS: A REVIEW OF PRACTICE ILLUSTRATED ON TYPE 316L STAINLESS STEEL PRODUCTS

Marko Kršulja[1a], Lovro Liverić[1b], Ivan Jandrlić[2]

[1]Faculty of Engineering, Juraj Dobrila University of Pula, Zagrebačka 30, 52100 Pula, Croatia
[2]Faculty of Metallurgy, University of Zagreb, Aleja narodnih heroja 3, 44000, Sisak, Croatia
[1a] marko.krsulja@unipu.hr, https://orcid.org/0000-0003-0823-8083,
[1b] lliveric@unipu.hr, https://orcid.org/0000-0001-8714-6771,
[2] ijandrli@simet.unizg.hr, https://orcid.org/0000-0001-6683-6108

Abstract

Mill test certificates (MTCs) issued under EN 10204 remain the primary evidentiary basis for accepting metallic materials into industrial supply chains, yet documented cases of falsified or unverifiable certification show that reliance on supplier-issued documents alone carries residual risk. This paper reviews the current practice of material-quality verification - certificate types, known documentation-failure cases and the complementary role of independent re-testing - and illustrates the discussed principles on a real, representative set of procurement documentation for type 316/316L stainless steel plate, pipe and fitting products, alongside an apparently related in-house tensile re-test. The illustrative material is used only to exemplify, not to establish, the reviewed practice; all examined values satisfy the relevant standards. The review concludes that combining EN 10204-3.1 certification with a modest, risk-based programme of independent re-verification remains the most practical safeguard given currently available tools.

Keywords: *mill test certificate; EN 10204; material traceability; quality fraud; stainless steel 316L; independent verification*

1. INTRODUCTION

Metallic materials used in pressure equipment, piping systems and marine structures are supplied together with a mill test certificate (MTC) that records chemical composition and mechanical test results against the ordered product standard [1]. EN 10204 defines four inspection-document types, ranging from a non-specific statement of compliance (type 2.1) to a certificate co-signed by an inspector independent of the manufacturing department (type 3.2) [1]. In practice, the great majority of industrial deliveries - including the case reviewed here - are accompanied only by a type 3.1 certificate, issued and validated entirely inside the manufacturer's own quality department.

The adequacy of relying on self-issued certification has been challenged by documented cases. Hara and Fujimura examined the mechanisms behind quality-data fraud in Japanese manufacturing, centred on the Kobe Steel case, where falsified strength and composition data accompanied metal shipments to thousands of downstream companies over roughly a decade, and linked such fraud to misjudged technological capability under competitive pressure [2]. Deka and Sarkar systematised

the supplier-quality documentation chain in the automotive sector and compiled thirteen public documentation-failure cases from 2012-2024, finding that none was uncovered through the chain's own routine internal verification - implicating the verification layer itself, not only the document originators [3].

These findings motivate verification mechanisms outside the certifying manufacturer's own quality loop, such as EN 10204 type 3.2 co-signature or independent re-testing by the purchaser or a classification society. A related logic - that non-destructive weld assessment alone is insufficient and must be corroborated by destructive mechanical testing before a procedure can be qualified - was previously shown by the present authors for MAG-welded AISI 316L and DH36 joints [4]; this review extends that logic from weld-procedure qualification to incoming-material qualification, illustrated on a real set of procurement documentation.

2. ILLUSTRATIVE MATERIAL AND METHOD

To ground the review in practice, a real, representative set of procurement documentation for type 316/316L austenitic stainless steel was examined. The material is treated strictly as an illustrative example of the documentation landscape discussed in Section 1, not as a controlled experiment or a statistically representative sample. Four EN 10204-3.1 mill test certificates were reviewed, each covering a different product form supplied within the same general procurement scope:

- Plate, 5.0 mm, grade 1.4404 (316L), certified to ASTM A240 [5] / ASME SA-240 / EN 10088-2 [10], manufacturer Outokumpu (heats 85374, 85462);
- Pipe, 16" SCH10S, TP316/316L, certified to ASTM A312 [6] / ASME SA-312 / ASME B36.19, manufacturer Froch Enterprise (heat AIC070088);
- Pipe, 12" SCH10S, TP316/316L, same certifying standards, manufacturer Froch Enterprise (heat ALK070330);
- Short-radius 90° elbow, 16" SCH10S, WP316/316L-WX, certified to ASTM A403 [7] / ASME B16.9 [8], manufacturer Superinox Max Fittings (heat A2503382), including radiographic weld inspection.

A separate in-house tensile test report, issued by a shipyard mechanical laboratory under classification society surveillance, was also reviewed. Handwritten annotations on this report reference dimensions and heat numbers consistent with the four certificates above, noted here as a plausible instance of independent re-verification; as the annotations are partially illegible, the correspondence is not treated as an established finding.

3. RESULTS OF THE ILLUSTRATIVE EXAMPLE

Table 1. *Summarises the certified chemical composition of the four reviewed heats*

Heat / product	C	Si	Mn	Cr	Ni	Mo
Outokumpu 85374 (plate)	0.021	0.47	0.92	17.0	10.0	2.02
Outokumpu 85462 (plate)	0.025	0.52	0.90	17.2	10.0	2.02
Froch AIC070088 (16" pipe)	0.017	0.44	1.15	16.80	10.10	2.10
Froch ALK070330 (12" pipe)	0.019	0.46	1.14	16.70	10.20	2.09
Superinox A2503382 (elbow)	0.017	0.46	1.18	16.64	10.08	2.03
ASTM 316L requirement	≤0.030	≤0.75/1.00	≤2.00	16.00-18.00	10.00-14.00	2.00-3.00

Table 2. *Compares the certified mechanical properties with the corresponding standard minima, together with the values recorded on the (provisionally linked) in-house re-test report*

Product (heat)	Rm (MPa)	Rp0.2 (MPa)	A (%)	Hardness	Standard min. Rm/Rp0.2/A
Plate 85374/85462	598-621	312-343	48-54	182-193 HBW	485/170/40 (A240)
Pipe 16" AIC070088	641	353	52	87 HRB	485/170/35 (A312)
Pipe 12" ALK070330	629	370	52	89 HRB	485/170/35 (A312)
Elbow A2503382	589	268	60.5	90.5 HRB	485/170/30 (A403)
In-house re-test (4 specimens)	595-630	288-390	50.7-57.3	-	as above

In this illustrative example, every certified and re-tested value exceeds the applicable minimum tensile strength, yield strength and elongation with a wide margin (21-32%, 58-118% and 27-73% respectively), and all hardness values remain below the standard maximum - consistent with, though not proof of, adequate material quality, since a single example cannot substitute for systematic verification. The strength and elongation levels are also broadly consistent with behaviour previously reported by the present authors for the related grade X5CrNiMo17-12-2 [9].

4. DISCUSSION

The literature reviewed in Section 1 indicates that certification failures - through outright falsification [2] or structural weaknesses in the verification chain [3] - recur across sectors and time. Neither study suggests certificates are generally unreliable; both indicate that a certificate produced and validated entirely within the supplying organisation carries a residual, non-zero risk that routine paperwork review does not

detect. This is the gap EN 10204 type 3.2 certification and independent re-testing are meant to close, and the gap the illustrative example exemplifies.

In the example, a clear spread of mechanical properties is observed between product forms despite an identical nominal grade: the wrought elbow shows the lowest yield strength with the highest elongation, consistent with solution-annealing and water-quenching, while the welded pipes show the highest strength with intermediate ductility, consistent with cold work from forming and welding. Such spread is a normal consequence of manufacturing route, not a quality concern, but it illustrates why product-form-specific interpretation of certified data is advisable.

Where the (provisionally linked) in-house re-test values differ numerically from the certificate values, both remain inside the standard's acceptance band. This pattern - independent measurement disagreeing in absolute terms yet agreeing on pass/fail outcome - is exactly the evidence a well-designed verification programme should produce, echoing the argument in [3] that verification value lies less in exact reconciliation than in an evidentiary path independent of the certifying party. A similar logic, that a formally documented independent measurement plan reduces acceptance risk beyond documentation review alone, was previously shown by the present authors in CMM-based dimensional quality control [11,12].

The illustrative example has clear limitations: a single heat per product form, a certificate-to-re-test link resting on partially illegible handwriting, and no quantified measurement uncertainty. These are the reasons the material is presented as illustrative rather than as new experimental evidence; a systematic, multi-heat dataset, ideally supported by digitised, machine-verifiable certificates as discussed in [3], would be needed to quantify how well independent re-testing agrees with supplier certification in general.

5. CONCLUSION

This review summarised the practice and known limitations of metallic material certification under EN 10204, drawing on documented certification-failure cases [2,3], and illustrated the discussed principles on a real set of procurement documentation for 316/316L stainless steel plate, pipe and fitting products. All certified and illustratively re-tested values satisfied the relevant ASTM/ASME standards. Given currently available tools, combining EN 10204-3.1 supplier certification with a modest, risk-based programme of independent re-verification remains a sound and proportionate safeguard against risks self-certification alone cannot eliminate; a systematic, multi-case study is a useful next step beyond the illustration given here.

ACKNOWLEDGEMENT

The authors thank the collaborating industrial partners for providing the documentation used as the illustrative example in this review. Moreover, this research was supported through the EU NextGeneration programme under the Juraj Dobrila

University of Pula institutional research project "Characterisation of Mechanical and Magnetic Properties of High-Entropy FeCoNiMnTi Alloys (CMM-HEA)", project number IIP_UNIPU_010151.

REFERENCES

[1] EN 10204:2004, Metallic products - Types of inspection documents, European Committee for Standardization, 2004.

[2] H. Hara, S. Fujimura, Why does quality fraud occur? A case study of Japanese manufacturers, Technology in Society, 78 (2024) 102659, doi: 10.1016/j.techsoc.2024.102659.

[3] D.J. Deka, N. Sarkar, Compliance Evidence in the Automotive Supply Chain: A Systematisation of the Quality-Document Spine and a Taxonomy of Documentation Failure Modes, arXiv:2607.04924 [cs.CE], 2026.

[4] M. Kršulja, D. Karabaić, L. Liverić, S. Grudić, Comparison of non-destructive and destructive welding assessment tests on mag-welded AISI316L and DH36 steels using K-309LT filler, in: 56th International October Conference on Mining and Metallurgy Proceedings, Balanović, Lj.; Tanikić, D. (Eds.), University of Belgrade, Technical Faculty in Bor, Mining and Metallurgy Institute Bor, Bor, 2025, pp. 421-425, doi: 10.5937/ioc25421k.

[5] ASTM A240/A240M-20a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications, ASTM International, 2020.

[6] ASTM A312/A312M, Standard Specification for Seamless, Straight-Seam Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes, ASTM International.

[7] ASTM A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings, ASTM International.

[8] ASME B16.9, Factory-Made Wrought Buttwelding Fittings, American Society of Mechanical Engineers.

[9] M. Kršulja, Z. Car, H. Radelja, Behaviour of X5 CrNiMo 17-12-2 Material During Deep Drawing Process, Metalurgija, 51 (2012) 2, 203-206.

[10] EN 10088-2:2014, Stainless steels - Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes, European Committee for Standardization, 2014.

[11] R. Matković, M. Kršulja, B. Barišić, M. Plančak, CMM Measurement and Measurement Quality Plan for Dimension Control, CA Systems in Production Process Planning, 12 (2011) 1, 87-90.

[12] D. Božić, M. Kršulja, B. Barišić, R. Matković, M. Lazanja, Investigation of a Quality Measurement Plan for an Alternator Carrier on a CMM Machine, in: Quality and Innovation in Engineering and Management, Editura U.T.Press, Cluj-Napoca, 2011, pp. 27-30.