

20 Material Test Reports (MTRs)

A Material Test Report (MTR) is a document that provides evidence that a material meets a specified standard. MTRs are commonly used for pipe, fittings, flanges, valves, pressure vessel components, and structural materials used in pressure systems.

An MTR answers a simple but important question:

How do we know this material is what the supplier claims it is?

Without documentation, it is often impossible to determine whether a piece of steel is suitable for a particular service simply by looking at it.

20.1 Why MTRs Matter

Many materials appear identical while possessing very different mechanical and chemical properties.

For example:

- ASTM A53 pipe
- ASTM A106 pipe
- Stainless steel pipe
- Alloy steel pipe

may appear similar, yet have very different service limitations.

An MTR provides documented evidence of:

- Chemical composition
- Mechanical properties
- Manufacturing information
- Traceability information

MTRs are therefore an important part of quality control and pressure equipment safety.

20.2 What Is a Heat?

Steel is manufactured in batches known as heats.

During production, molten steel is processed in a furnace and assigned a unique heat number.

The heat number identifies the specific batch of material from which a component was produced.

20.3 Heat Numbers

A heat number provides the connection between a physical component and its documentation.

For example:

Pipe Marking:

ASTM A106 GR B
HEAT 12345

The heat number allows inspectors to locate the corresponding MTR and verify the material properties of that batch.

This process is called **material traceability**.

20.4 Information Found on an MTR

Although formats vary by manufacturer, most MTRs contain:

- Manufacturer name
- Material specification
- Material grade
- Heat number
- Chemical composition
- Mechanical test results
- Applicable standards
- Certification information

20.5 Chemical Composition

An MTR typically lists the chemical composition of the material.

Examples include:

- Carbon (C)
- Manganese (Mn)
- Silicon (Si)
- Phosphorus (P)
- Sulfur (S)

Additional alloying elements may also be listed.

The reported values are compared against the limits established by the applicable specification.

20.6 Mechanical Properties

An MTR typically includes test results for:

- Tensile strength
- Yield strength
- Elongation

These properties help demonstrate that the material has the required strength and ductility.

20.7 Reading a Typical MTR

An inspector reviewing an MTR may verify:

1. The material specification.
2. The material grade.
3. The heat number.
4. Chemical composition.
5. Mechanical properties.

The heat number on the MTR must match the heat number marked on the component.

If the numbers do not match, traceability has been lost.

20.8 Maintaining Traceability

Traceability is only useful if it is preserved.

When pipe is cut into shorter sections, shops often transfer the heat number to each piece.

Common methods include:

- Paint markers
- Metal tags
- Stamping
- Traceability records

If the heat number is lost, proving material compliance may become difficult or impossible.

20.9 Missing Traceability

A component does not necessarily become defective if its heat number is lost.

However, it may no longer be possible to prove:

- What specification it meets
- Which heat it came from
- Which MTR applies to it

In code work, lack of traceability can create significant problems during inspection.

20.10 Why Pipefitters Should Care

Material traceability is not solely an engineering concern.

When markings are removed, painted over, or discarded, the connection between the component and its documentation may be lost.

Maintaining traceability helps ensure that the correct materials are installed and that compliance can be demonstrated during inspections.

20.11 Key Takeaway

A Material Test Report is the document that proves a material meets its specified requirements. The heat number provides the link between the physical component and the MTR. Maintaining that link is essential for material traceability, quality control, and code compliance.

20.12 Sample Documents

The following examples illustrate how material traceability is established in practice.

Notice that no single document contains all of the information. Instead, the invoice, material certificates, and heat numbers work together to create a chain of traceability linking the purchased component to the manufacturer's test records.

20.12.1 Invoice

The invoice identifies the material that was purchased and received.

10	PSX05 1/2 XS SRL BLK A106B SML PIPE HT# MF 054 001 02L CUT ABOVE PIPE INTO (3) PCES	FT	21.00	21.00	✓	.00	3.7800	79.38
40	CUT011 LABOR-CUT ON 1/8"-1" STL PIPE 100 000 00A	UN	3.00	3.00	✓	.00	4.9500	14.85
60	PSX03 3/8 XS BLK A106B SML PIPE HT# MF 054 001 02K CUT ABOVE PIPE INTO (3) PCES	FT	21.00	21.00	✓	.00	2.8500	59.85
90	TFS07 3/4" THRD 105N FS 3000# TEE HT# MF 011 002 01A	UN	15.00	.00	15.00		11.3200	
100	TFS1 1" THRD 105N FS 3000# TEE HT# MF 011 002 01J	UN	15.00	12.00	✓	3.00	14.3700	172.44

The invoice provides information such as:

- Part number
- Material description
- Size
- Quantity
- Manufacturer
- Purchase information

In this example, the handwritten heat numbers create the connection between the items on the invoice and the supporting material certificates.

For item 10, the handwritten heat number **18R103** identifies the corresponding pipe certificate.

For item 100, the handwritten heat code **CA1314** identifies the corresponding tee certificate.

The invoice therefore acts as the first link in the traceability chain.

20.12.2 Mill Test Certificate

The heat number **18R103** and the description **1/2" XH X WT 0.147" X 21 FEET Long** connect this document to line 10 of the invoice.

MILL TEST CERTIFICATE																	
CERTIFICATE ACCORDING TO EN 10204 B.1																	
PURCHASER NAME :			ALBERTA PIPE FITTINGS LTD					TEST CERTIFICATE No.:			0754/2022						
PURCHASER ORDER No. :			APF/LB04			Date :		22-03-2022		TEST CERTIFICATE Date :							
WORK ORDER No. :			LBST / WO / EXP / 5971			Date :		06-04-2022		INVOICE NO:							
NAME OF STEEL SUPPLIER :			RASHTRIYA ISPAT NIGAM LIMITED - INDIA - Melt & Pour					INVOICE Date :			03.08.2022						
STEEL MAKING METHOD :			BOF-LF/IRUT-CCM-ROUND METHOD, Fully Killed and Fine Grain Practice.														
PROCESS OF PIPE MANUFACTURE :			CDS / CS / PIPES														
MANUFACTURE PROCESS ROUTE :			PM-HI-STP-CD-HT-Finishing-NDT-P&F-Dispatch.			CUSTOMER UID NO		-									
SPECIFICATION & GRADE :			ASTM A106 GR.B(Ed.2015)/ASME SA106 GR.B(Ed.2019), CSAZ245.1 CAT I GRADE 290(Ed.2018),NACE MR0175/ISO 15156(Ed.2020), NACE MR0103/ISO 17545(Ed.2016)														
Sr. No.	LBST HEAT NO	SUPPLIER HEAT NO	SIZE				Quantity			General							
			OD (INCH)	ID (INCH)	WT (INCH)	Length (FEET)	Nos.	FEET.	MT.	End Condition	Coating						
1	18R103	22E00436	1/2" XH X WT 0.147" X 21 FEET Long.				135	2835.09	1.400	Plain End	Black Paint						
CHEMICAL COMPOSITION (%)																	
Sr. No.	HEAT NO	REQUIRED	%C	%Mn	%Si	%S	%P	%Cr	%Ni	%Cu	%Mo	%V	%Nb	%B	%Ca	%Al	%C.E
		Min	-	0.29	0.10	-	-	-	-	-	-	-	-	-	-	-	-
1	22E00436	Max	0.30	1.35	-	0.025	0.025	0.30	0.40	0.40	0.12	0.08	-	-	-	-	-
		L/A	0.18	0.61	0.15	0.005	0.017	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.030	0.287
		P1/A	0.18	0.61	0.14	0.005	0.017	0.016	0.002	0.004	0.001	0.002	0.001	0.001	0.003	0.029	0.288
		P2/A	0.18	0.61	0.15	0.005	0.016	0.018	0.002	0.004	0.001	0.002	0.001	0.001	0.003	0.029	0.288
MECHANICAL PROPERTIES																	
Sr. No.	HEAT NO	REQUIRED	YIELD STRENGTH (MPa)	TENSILE STRENGTH (MPa)	ELONGATION (%)	HARDNESS(BHN)	IMPACT TEST	BEND TEST	FLARING TEST	GRAIN SIZE							
			G.L. > 50 mm. Pipe tested in full section (Orientation- Longitudinal)														
1	18R103	Min	240	415	30	-	-	-	-	-							
		Max	-	-	-	200	-	-	-	-							
		329.44	460.21	49.00	119 - 121	NA	OK	NA	7.0 - 7.5								
NON-DESTRUCTIVE TEST																	
Sr. No.	HEAT NO	STRAIGHTNESS	HYDRO-STATIC TEST as Per ASTM A630 and holding time 8 sec min(100%)	E.C.T. as Per ASTM E 309 (100%) (Drill hole-1/4 mm)	U.T. AS PER ASTM E- 213 (100%)	VDI	IN SIDE / OUT SIDE	RA VALUE	PMI								
1	18R103	Satisfactory	2500 PSI OK	OK	NA	Satisfactory	Satisfactory	NA	Satisfactory								
Heat Treatment : Heat Treated Above 650°C (1200°F), Annealed condition																	
MARKING: LBST /  CDS / ASTM A106B/ASME SA106B/CSAZ245.1 CAT 1 GRADE 290/NACE MR0175/ISO MR15156/ NACE MR 0103/ ISO 17545 1/2", XH X WT 0.147" X 21.0 FEET/ HEAT NO. 18R103 / NDE/HYD. 2500 PSI/MADE IN INDIA																	

A typical mill test certificate contains:

- Manufacturer information
- Material specification
- Material grade
- Heat number
- Size and dimensions
- Chemical composition
- Mechanical properties
- Heat treatment information
- Hydrostatic test results
- Non-destructive examination results
- Certification statement

In this example, the certificate identifies the pipe as:

- ASTM A106 Grade B
- ASME SA106 Grade B
- Heat Number 18R103
- 1/2" extra-heavy seamless pipe

The chemical analysis demonstrates that the material composition meets the applicable specification, while the mechanical test results demonstrate that the required strength properties have been achieved.

20.12.3 Certificate of Test

The Heat Code **CA1314**, Heat Number **382611Z**, and description **1 3M THD TEE 105N** connect this document to line 100 of the invoice.



Certificate of Test

ITEM INFORMATION														
Part Number:		0366708154		Description:		1 3M THD TEE 105N								
Heat Code:		CA1314		Heat Number:		382611Z								
Reference No.:														
Part Specification:		ASTM A105/A105M-21 / ASME SA105-19												
CHEMICAL ANALYSIS %														
C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Cb/Nb	N	CE	Ti	CE
0.19	1.06	0.014	0.002	0.21	0.03	0.02	0.06	0.01	0.002	0.002	0.005	0.38	0.002	0.384
CE (LONG FORMULA) = 0.384														
PHYSICAL PROPERTIES														
Yield KSI	Yield PSI	Yield MPA	Tensile KSI	Tensile PSI	Tensile MPA	Elongation	REDUCTION OF AREA %	HARDNESS 1 BHN/HRC	HARDNESS 2 BHN/HRC					
55.0	55000	379	76.9	76900	530	38	70	147	149					
Heat Treatment: NORMALIZED.														

A certificate of test for a fitting typically contains:

- Manufacturer information
- Part number
- Material specification
- Heat code
- Heat number
- Chemical composition
- Mechanical properties
- Heat treatment information

In this example, the certificate identifies the fitting as:

- ASTM A105 / ASME SA105 forged carbon steel
- 1" threaded tee
- Class 3000 fitting
- Heat Code CA1314
- Heat Number 382611Z

The document also provides the chemical analysis and mechanical properties of the material from which the fitting was manufactured.

20.12.4 Following the Traceability Chain

The process of traceability can now be followed from one document to another:

Invoice
↓
Heat Number 18R103
↓

Pipe Mill Test Certificate

Invoice

↓

Heat Code CA1314

↓

Certificate of Test for Tee

An inspector reviewing the installation can therefore verify:

- What material was purchased.
- Which heat the material came from.
- The chemical composition of the material.
- The mechanical properties of the material.
- Compliance with the specified standard.

This ability to follow the chain from component to certificate is the foundation of material traceability.

20.13 Material Identification vs. Material Certification

A marking on a pipe, fitting, or valve identifies the component. An MTR provides the documentation that supports that identification.

For example, a pipe marked ASTM A106 Grade B may appear to be suitable for service, but without the corresponding MTR there may be no way to verify the material's chemistry, mechanical properties, or traceability.

Markings and documentation work together. One does not replace the other.

20.14 Not Every Component Requires an MTR

Material test reports are common for pressure-retaining components such as pipe, fittings, flanges, and valves used in code construction.

However, not every item in a plant will have an associated MTR. The documentation requirements depend on the governing code, quality program, purchaser requirements, and intended service.

20.15 The Inspector's Question

When reviewing a pressure system, an inspector is often asking a simple question:

"Can you prove that this component is what you say it is?"

The purpose of markings, heat numbers, and material test reports is to provide that proof.

If the traceability chain can be followed from the installed component back to the supporting documentation, the material can be verified. If that chain is broken, verification may no longer be possible.