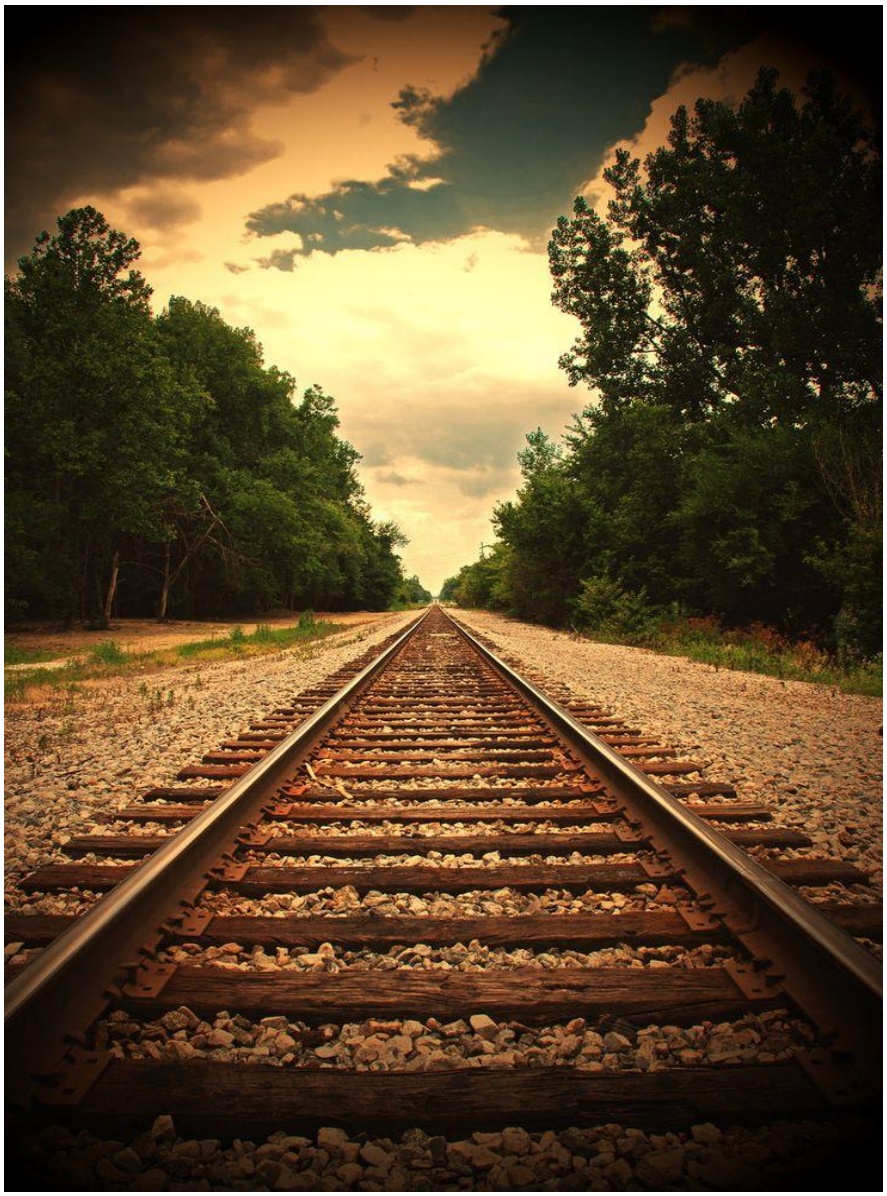

GREEN TEAM TECHNICAL REPORT

Technical Report

Created by Matteo Atlixco, Hannah Thomson, Ashten Nichols, Micah Haile
MNFG-290

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History and Use:

Railway tracks were created all the way back in the 700bc. Used to ship goods across the Isthmus of Corinth, measuring between 6-8 km. These tracks were made of wood and stone. Lasting a 650-year period, Diolkas was used until the middle of the 1st century.

In the early 1800s Matthew Boulton and James Watt founded the locomotive steam engine capable of a high power to weight ratio. In the coming years their patent expired, allowing others to build suitable steam locomotives. This leads to a mass increase in railways. The development railways in the 19th century changed our perspective on fast transportation here in Canada. During the industrial revolution the first type of steam train came into play into our way of transporting goods across the nation. Before the industrial revolution, the first type of industrial railway track was built in 1798 near Wakefield, England. Its primary use at the time was to transport coal out of a mine. This railway spanned 3 miles and was mainly powered by horses. From 1798 up to the start of the industrial revolution. The building of the Liverpool and Manchester railway took place. This railway spanned a staggering 2100km distance. Sparking the new age of the promotion of railways "The Mania" in 1844. Railroad tracks were going to be the cornerstone of transportation at great distances. In 1871, British Columbia was persuaded into joining the confederation after a 1600km line was proposed. This line would be longer than the US's first transcontinental line. In 1825 John stevens would create the first built American steam locomotive starting the steam locomotive era in the US. (WIKIPEDIA 3, 2025) (The canadian encyclopedia , 2021)

Transcontinental highways in Canada & modernization

The CPR (Canadian pacific railroads) was the creation of transcontinental railroads in Canada. This massive line would connect cities like Vancouver and Winnipeg. Other western towns would "string on" to the railroad and more towns were built around the movement of goods trans-continentally. In 1900 the CNR (Canadian norther railway) was created to Combat the rush of immigrants into the country and the drastic increase in agriculture. It would branch off into small towns like Regina, Saskatoon, Edmonton, Etc. Eventually Prime minister Wilfrid Laurier enthusiastically encouraged a Third transcontinental highway spanning from Winnipeg all the way to Moncton NB. It was completed in 1913 and would cost $160 million. At this time this was well into the golden era of Railways in the Canada and the US, standards were put into place. A standard-gauge railway is to be 4ft 8.5 inches in width. After the rise of the railway. World wars I and II came

in and ruined the Canadian and American economies. Immigration would be at an all time low during this time, and due to the Wars, A serious push in technological advancement occurred bringing automotive mobiles into the equation. This would further hinder the use of railroad tracks to transport goods and people. The automobile was Popularizing. Despite the decline in passenger trains in the US and Canada, the freight train remained a strong tool in large countries like, Russia, Canada, And the US. Mainly because long distances between cities needed to be covered. This is a more economical choice for large quantity goods such as coal and items for agriculture and manufactured items. In newer types of modern-day technology, Train tracks have been modernized for human transport across shorter distances. For example, Calgary's C train is a large railway built for the transportation of people throughout the city. A railway track was maintained constantly as the tracks had to battle the constant use from locomotives and the harsh quick changes in Canadas environment.

Manufacturing materials

Railroad tracks date back to around the 16th century, as then they were known as "Wagon ways" Utilizing wooden rails to guide horse-drawn carts in many operations like mining. For the time using wood was sensible because of the abundance but the wear of the planks was very significant and were prone to wearing very quickly, often to having to be replaced very frequently and raising the question to what could be used to stop this issue.

(Wikipedia, 2025) (EVERTRACK, 2024)

"A different system was developed in England, probably in the late 16th century, near Broseley for conveying coal from mines, sometimes drift mines down the side of the Severn Gorge to the River Severn". (Wikipedia, 2025)

" The gauge was usually narrow, to enable the wagons to be taken underground in drift mines. the gauge was usually narrow, to enable the wagons to be taken underground in drift mines". (Wikipedia, 2025)

In around the 1730's, cast iron strips were being placed on top of the said wooden planks giving the railing system more durability and reducing the wear of the wood but not equipped for the newer Trains systems being developed, heavier and heavier loads once again caused more "excessive maintenance". This was known to many as Strap -iron Rails or Strap Rails. (EVERTRACK, 2024) (World Wide Rails, 2025) (Wikipedia, 2025)

"**Cast iron strips could be laid on top of timber rails, and the use of such materials probably occurred in 1738, but there are claims that this technology went back to 1716. In 1767, Ketley Ironworks began producing cast iron plates, which were fixed to the top of wooden rails with nails, to provide a more durable running surface. This construct was known as Strap iron rails (or strap rail)**. (Wikipedia, 2025)

Now in-between 1813 and 1820 were “Wrought Iron Tracks” or the more “Modern” types of railway tracks were being developed and used to accommodate the heavier hauling locomotives. Using a I shaped beam compared to T shaped beams, 0, is a very low carbon iron alloy (mild steel) containing less than 0.05% of carbon, making it malleable/ ductile, corrosion resistant and easily forged. (Wikipedia, 2025) (AGICO GROUP, 2023)

” The breakthrough came when John Birkinshaw of Bedlington Ironworks in Northumberland developed rolled wrought iron rails in 1820 in 15 feet (4.6 m) lengths” (Wikipedia, 2025)

“Wrought iron was the next material used in railway tracks. The tracks were made by heating and shaping the iron into rails and then assembling them on-site. Wrought iron tracks were stronger and more ductile than cast iron tracks, but they were still prone to cracking and had a shorter lifespan.” (AGICO GROUP, 2023)

Getting into the era of currant steel railer road tracks like first being said to be used in 1860 steel railroad tracks are what you can call the modern standard. Carbon steel, High carbons steel, stainless steel, and Steel alloys, the different types of Tracks are sued in my types of scenarios like intercity LRT/ Trains systems, bullet trains, cross county, plant/ national rail yards, and the specific type of material varies on the application. There are also some new track types like composite and concrete rails that are used for other purposes when you want very low maintenance, with stand higher load capacity (**concrete**), faster speed ratings (**concrete**), Chemical, UV and thermal resistant (**Composite**), easier to install (**Composite**), reduced noise and vibration (**Composite**) and withstand more wear and tear but are usually a lot more expensive .**“The first rails made from steel were made in 1857, when Robert Forester Mushet remelted scrap steel from an abortive Bessemer trial, in crucibles at Ebbw Vale ironworks, and were laid experimentally at Derby railway station on the Midland Railway in England”** (Wikipedia, 2025)

” Steel is currently the most widely used material for railway tracks. Steel tracks are strong, durable, and have a longer lifespan than cast iron or wrought iron tracks. Steel tracks are made from various types of steel, including carbon steel, high carbon steel, alloy steel, and stainless steel” (AGICO GROUP, 2023)

“Concrete tracks are a newer option for railway tracks and have been gaining popularity in recent years. Concrete is a versatile and durable material that can withstand extreme temperatures and weather conditions. There are two main types of concrete tracks” (AGICO GROUP, 2023)

“Composite tracks are made from a combination of materials, such as fiberglass and plastic. These tracks offer unique advantages such as reduced noise and vibration, increased durability, and lower maintenance costs.” (AGICO GROUP, 2023)

In short, Railway tracks are a critical part of any railway system, and the materials used to make them are key to their durability, and performance. Traditional materials like cast iron, wrought iron, and steel have been widely used because they are strong and easily available. But have downsides, like easily rusting and requiring frequent or constant maintenance. Newer materials, like concrete or composites, solve some of these issues by being resistant to corrosion and easier to maintain, while still being strong. But they can be expensive and need special installation.

Machines used in manufacturing

Blast Furnaces

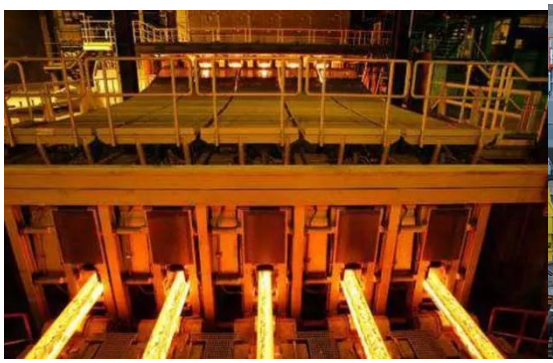
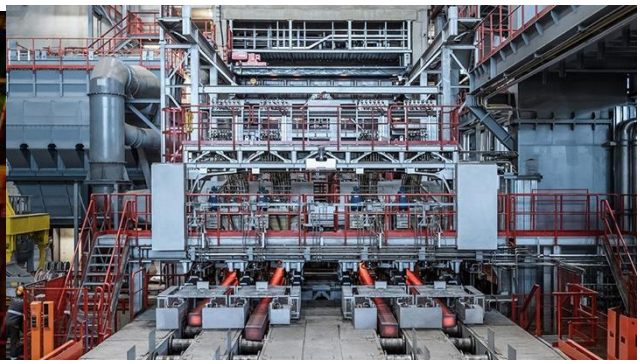
- After the materials to make up molten iron are collected, industrial furnaces are used to combine the different materials into molten iron.


Basic Oxygen Furnace (BOF)

- Takes the molten iron from the blast furnace along with scrap metal and converts it into molten steel by adding high velocity oxygen removing impurities.

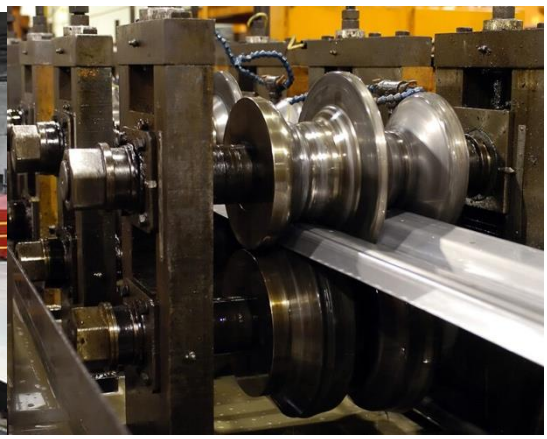

Continuous Casting machine

- Continuously runs the molten steel through the machine resulting in high quality, solid slabs of steel. It goes through the ladle, the tundish, then solidified in a water-cooled mold.

Shaping rolling mills (universal rolling mill)

- After making the base steel slabs, they are then shaped into long, t-shaped, straight steel rods. This is accomplished by the rolling mills that use a combination of heat and pressure to elongate the length to around 4 times as long as the slabs. Specifically, the universal mill would be ideal compared to others because of its ability to deal with different shapes and higher precision.

Heat Treatment

- In this production system the usual preferred method of heat treatment is quenching and tempering. This is to try and increase yield and tensile strength as well as stabilizing the microstructure.


Precision cutting/Straightening tools and machines

- After cooling and being allowed to settle, a straightening machine works on both the horizontal and vertical aspects and a precision cutting machine will cut the steel rods to length. (Zhong zei , n.d.)


Grinding

- The straightened steel rods are put through the grinder to ensure surface smoothness. These machines, like rail grinders and grinding trains, use rotating stones to smooth and face the rail surface both during and after manufacturing.


Shot peening

- Shot peening machines help extend the wear and durability of components by blasting a special medium at high speed onto the material's surface. Usually involving shots made from cast Iron beads or glass beads.


Production system overview:

The system to produce railroad tracks is likely created using the format of a flow shop manufacturing system. This system holds benefits that would support the efficiency and volume of production. It allows a greater volume of tracks to be produced on a consistent basis, relying on the standardization of the different parts as well as the proven, reliable step by step flow shop method. Although the setup and preparation time is generally more drawn out in comparison to other methods, it balances out by saving a significant amount of time while doing the physical production. (Agico group tm, 2023) (Stainlessinox, 2019)

Safety is one of the top concerns in the manufacturing of railways as the people operating the machines to build them and overseeing the construction are constantly at risk. Some of the key priorities for safety include inspector conduct, adherence to FRA standards, guardrail strength, proper inspection documentation, reviewing safety rules in advance, and clearly communicating safety protocols to workers. (1996-12_Railroad_Workplace, n.d.)

This process requires a good number of **workers**. Engineers and metalworkers plan and direct production, guaranteeing effectiveness and quality. The machine operators oversee the equipment used to cast, roll, and finish the rails. While site workers build and assemble the track, ensuring that everything is correctly aligned and secured, logistical workers organize transport.

The manufacturing process is as follows:

1. Source Raw Materials
    - Collect materials used in the construction of the tracks, some varieties of the primary ones include Iron Ore, Coke(carbon), and Limestone, steel, concrete, composite.
2. Prepare Materials
    - Cleaning and combining materials into steel using two types of furnaces
        - Blast Furnaces
        - BOF (basic oxygen furnace)
3. Quality Control Check

- check over the quality of the new compound for imperfections before it is put through the manufacturing process
- Rejections are sent back to the previous step

4. Continuous casting
   - Solidifying the steel into rods by heating the steel into molten steel and the use of a mold
     - Continuous casting machine
5. Rolling the Rail
   - Putting the rods of steel through rollers to heat then shape them to the specification of the standard train wheel size
     - Universal Rolling Mill
6. Heat Treatment
   - Quenching and tempering the rail after shaped to improve yeild and tensile strength
     - Heat treatment machines
7. Quality control
   - Examine rail to confirm heat treatment affected the structural integrity properly
   - Rejects are sent back to step 5
8. Cut to Length/straightened
   - The rails are straightened and cut to size for easier Transportation and construction
     - Precision cutting tools
9. Quality Control
   - Inspect for anything that could affect rail performance such as cracks or other imperfections both on the surface and internally.
   - Rejects are sent back to step 5
10. Surface finishing

- Ensuring a smooth surface through grinding and shot peening
    - Grinder
    - Shot peening machine

11. Surface Treatment
    - Add a layer of protective coating to the perfected and inspected rail to ensure a longer lifetime
12. Assembling rail track
    - Combining the components of a railway including the rail track, wooden or concrete ties, steel fasteners, gravel ballasts, and others on site of the future track
13. Quality control
    - Ensuring all parts have been assembled correctly and all safety steps have been taken while assembling
    - Rejects are sent back to the previous step
14. Laying the track
    - Rails are carefully aligned and secured with the ties and fasteners creating the railway track
15. Quality control
    - Regular Maintenance and Inspection are key components for having a long lasting /reliable and stable trackway for use

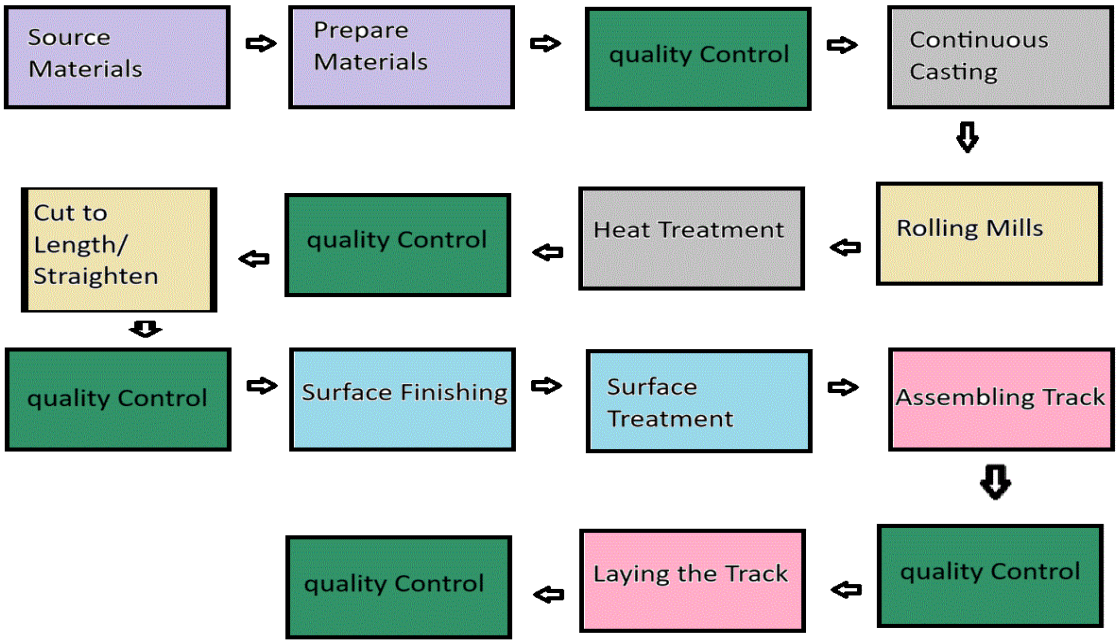


Figure 1: Production of system overview flow chart

Quality control steps

Quality control steps taken for railroad tracks first start with ensuring the material quality, making sure the materials used in the specific rail being produced is vital, ensuring that the proper compound of steel is used and being advised under the ruling of Trasport Canada,

“Quality assurance (QA) means a systematic set of activities carried out by QA personnel to verify that the work is done in accordance with the railway company’s standards and procedures, and in compliance with the TSR **“-** (Tc Canada, 2021)

To adhere to Engineering Specification for industrial rail tracks for steel, dimensional checks, uses of ultra sonic testing and welding inspections are some of the checks performed on the materials before they get sent out for manufacturing.

(Tc Canada, 2021). (CN, 2025)

The manufacturing control steps start with rolling process monitoring, ensuring a uniform rail profile during the hot rolling phase, watching for any possible deviations in one of the first steps of forming this metal railing. Cooling control mitigates any unwanted/ undesirable microstructural changes to the formed material, giving certainty to staff making the product that on a molecular the formed piece of steel inn within the guidelines and specifications of what the engineers have set. Surface defects are inspected with a wide range of methods but one of the more popular ones is a non – destructive testing called Eddy Currant testing or Magnetic Particle testing

(CN, 2025) (Tc Canada, 2021) (Wirth Rail, 2025)

“In Canada, companies like M.F. Wirth Rail Corporation emphasize rigorous quality control in rail manufacturing. They state that "rails are subjected to visual and ultrasonic testing as well as checks for line straightness, dimensional tolerances and more.” - (Wirth Rail, 2025)

Pre installation inspections and Quality control are in place to be a final process before each rail is send out into their real-world working application. Design compliance ensures each track complies with the respecting safety requirements for federal regulated railway track standards, one of Canada’s major railway companies, CN (Canadian National), track management is an inspections and maintenance program designed to ensure safety and assurance to their workforce, providing a failsafe to all track that are going to be used in railyards or national rail lines (Tc Canada, 2021)

"Ensure track designs comply with the *Rules Respecting Track Safety*, which prescribe minimum safety requirements for federally regulated standard gauge railway track. Conducting inspections as outlined in CN's *Track Management Program"* – (CN, 2025)

Post-installation Quality Control, Regular Maintenance and Inspection are key components for having a long lasting /reliable and stable trackway for use. Track geometry is one of the factors for having the quality mentioned above, using Rail cars build for track geometry they can measure gauge and alignment to make sure its within spec. Stress and Fatigue testing is another factor used to sure long lasting and durable railways, monitoring rail stress levels under curtain loading conditions and seeing if it within stands that testing being performed, may notes are taking into conidiation from different points along the 52 foot piece of rail that are used to conduct if the rail is still suitable for use. Visual inspection, more Ultrasonic testing, Thermal expansion monitoring, Track deflection Grinding and Profiling are more examples of post installation and Maintenance/ Inspection testing used to upkeep and monitor rail over the years to ensure the quality for it workers and the safety to the public, making sure that accidents are kept to a minimum i.e.; Broken or cracked rail, and rail is upheld to the level of quality set by the federal government.

(Tc Canada, 2021)

Quality Control and inspection is vital for the rail industry, without it there could be many instances of broken rail that could've caused catastrophic damages to the cities we love or nature that's what make Canadas beauty is what it is, the many different standards and procedures are there to ensure that people like ourselves to the workers on them endlessly are safe and have a reliable means of transporting good around Canada.

Comparison of two manufacturers

Before the comparison, let's start with understanding what ISO 9001 and 14001 are and why they matter in this comparison.

Created by the **International Organization for Standardization (ISO)**, ISO 9001 is a global standard for quality management systems (QMS). It helps businesses consistently meet customer expectations and regulatory requirements while driving continual improvement in their operations.

ISO 14001 is the internationally recognized standard for environmental management systems (EMS). It provides a framework for organizations to design and implement an EMS and continually improve their environmental performance.

The companies/manufacturers we are to do the comparison between are **ArcelorMittal** and **Voestalpine AG.** (voestapline) (ArcelorMittal, 2024)

ArcelorMittal is a multinational steel manufacturing corporation headquartered in Avenue de la Liberté, Luxembourg. It was formed in 2006 from the takeover and merger of Arcelor by Mittal Steel. ArcelorMittal is the world's largest steel producer, with an annual crude steel production of 93.6 million tones as of 2012. It is ranked 91st in the 2013 Fortune Global 500 ranking of the world's biggest corporations. It has steel-making operations in 15 countries, including 37 integrated and mini-mill steel-making facilities.[1] In 2023, the company's production was 39% in the Americas, 50% in Europe and 11% in other countries, such as South Africa and Ukraine.[1] The company is vertically-integrated and produces 57% of its iron ore needs, 7% of its coal needs, 98% of its coke needs, and 59% of its scrap and direct reduced iron needs.

Starting since 1990, ArcelorMittal had been producing high speed rails. They claim that with more than 1.500.000 tonnes, supplied, of this product. At present, it can supply individual bars up to 120 metres long with maximum reliability, geometrical precision, strict flatness and the highest quality on the market.

"ArcelorMittal has developed state-of-the-art systems for steel production, which allows the supply of top-quality raw material, and a production process that detects any possible anomaly,

whether internal or external, together with the equipment required for rails to comply the strictest dimensional tolerances." - (ArcelorMittal, 2024)

ArcelorMittal has been producing **high speed rails** since 1990, with more than 1.500.000 tonnes, supplied, of this product. At present, it can supply individual bars up to 120 metres long with maximum reliability, geometrical precision, strict flatness and the highest quality on the market.

Voestalpine AG

is an Austrian steel-based technology and capital goods group based in Linz, Austria. The company is active in steel, automotive, railway systems, profilform and tool steel industries. As of 2017, it is one of the few profitable steel companies in Europe.

45 percent of its workforce is based in Austria. The Linz hot strip mill is a "fully integrated steel works" operated by voestalpine Stahl GmbH, a part of the steel division of voestalpine AG. In addition to Linz the most important plants are in Leoben in Styria and in Krems in Lower Austria. It had a large plant at Liezen in Styria which closed in the 1990s. Voestalpine is responsible for 10% of all Austrian CO_2 emissions, which makes it the biggest emitter in the country.

Company comparison

	ArcelorMittal	**Voestalpine**
Awards	★ Altair Enlighten Award	★ EMAS Award ★ CSR Rating ecovadis
Stock price (Jan 28, 2025)	23.73 EUR	19.45 EUR
Forbes Global 2000	**#1290**	**#421**
Revenue (2024)	$68.3B	$18.4B
Assets	$93.9B	$18.3B
Presence	Global with over 60 countries	Europe

Table 1: Company comparison

Manufacturing Comparison

	ArcelorMittal	Voestapine
Focus	Wide range of Rail Application, Cost effective, Mass Production	High quality, Premium, High Wear Resistance, Low Rolling Contact fatigue
Technology	Standard hot-rolled steel production	Heat treatment technology
Products	General purpose rails, Metro Systems, Mining applications	High Speed Rails, Turn out rails, Grooved Rails
Availability	Broader range of rail profiles and sizes	Customizable for Extreme Weather and geographic conditions
Priority	Quality and longevity Innovations and special treatments	Balanced quality and affordability Reliability

Table 2: Manufacturing table

Conclusion

If customers are looking for a reliable cost effective and general-purpose rail tracks that's extremely versatile and accessible, ArcelorMittal is where to go. However, if the customer is within the Europe and prioritizes Quality and minimal future maintenance costs, **Voestalpine** is a great choi

References

Agico Group 2. (2025). Retrieved from How Are Railroad Tracks Made: https://railroadrails.com/knowlege/how-are-railroad-tracks-made/

Agico Group. (2023, February 28). Retrieved from How Railway Tracks Are Made: https://rail-track.com/how-railway-tracks-are-made/

AGICO GROUP. (2023, febuary 27). Retrieved from What Material Is Railway Track Made Of?: https://rail-track.com/what-material-is-railway-track-made-of/

ArcelorMittal. (2024). Retrieved from American Standard: https://rails.arcelormittal.com/profiles/transport-rails/american-standards/

ArcelorMittal. (2024). Retrieved from Quality: https://rails.arcelormittal.com/about-us/quality/

Association of american railroads. (n.d.). Retrieved from Freight rail & automated track inspections: https://www.aar.org/issue/automated-track-inspections/

CN. (2025). Retrieved from Safety Guidelines and Regulations: https://www.cn.ca/en/customer-centre/safety-guidelines-and-regulations/track-specifications-and-maintenance/

Erkas. (n.d.). Retrieved from https://erkasmakine.com/boru-makinesi-kalip-imalati/

Evertrack. (2024, December 9). Retrieved from Tracking the Past: The History of the Railroad: https://evertrak.com/tracking-the-past-the-history-of-the-railroad/

EVERTRACK. (2024, December 9). Retrieved from Tracking the Past: The History of the Railroad: https://evertrak.com/tracking-the-past-the-history-of-the-railroad/

Frobes. (n.d.). Retrieved from ArcelorMittal: https://www.forbes.com/companies/arcelormittal/

GYT. (n.d.). Retrieved from https://www.induction-heatingequipment.com/sale-2332539-electric-quenching-machine-induction-heating-equipment-of-immersion-hydrojet-cooling.html

ISO. (2021). Retrieved from https://www.iso.org/standard/60857.html#:~:text=ISO%2014001%20is%20the%20internationally,continually%20improve%20their%20environmental%20performance.

ISO 9001. (2025). Retrieved from https://iso9001.com/#:~:text=Created%20by%20the%20International%20Organization%20for%20Standardization,they%20deliver%20high%2Dquality%20products%20or%20services%2D%2Devery%20time.

picture 1. (n.d.). Retrieved from https://www.engineeredabrasives.com/images/EA-automated_shot_peening_machine_8.jpg

Reddit. (2024). Retrieved from Arcelormittal: https://www.reddit.com/r/Arcelormittal/?rdt=41753

Tc Canada. (2021, May 31). Retrieved from rules respecting track safety : https://tc.canada.ca/sites/default/files/2021-10/rules-respecting-track-safety-may-31-2021.pdf

The canadian encyclopedia . (2021, July 9). Retrieved from Railway History in Canada: https://www.thecanadianencyclopedia.ca/en/article/railway-history

voestapline. (n.d.). Retrieved from continuous casting machines: https://www.voestalpine.com/stahldonawitz/en/products-and-technologies/production/continuous-casting-machines/

Wattsan. (n.d.). Retrieved from https://wattsan.com/

Wemac. (n.d.). Retrieved from Steel Making : https://www.wermac.org/steel/steelmaking.html

Wikipedia. (2025). Retrieved from History of the railway track: https://en.wikipedia.org/wiki/History_of_the_railway_track

Wikipedia. (2025, january). Retrieved from https://en.wikipedia.org/w/index.php?title=ArcelorMittal&action=history

WIKIPEDIA 3. (2025, february 14). Retrieved from Timeline of railway history : https://en.wikipedia.org/wiki/Timeline_of_railway_history#:~:text=1798%20%E2%80%93%20The%20Lake%20Lock%20Rail,was%20hauled%20by%20one%20horse

Wirth Rail. (2025). Retrieved from Quality rails, on time, Worldwide: https://wirthrail.com/

World Wide Rails. (2025). Retrieved from What are railroad tracks made of? : https://worldwiderails.com/what-are-railroad-tracks-made-of/

Zhong zei . (n.d.). Retrieved from China coal: https://www.railwayintl.com/pdd/188