COALITION for
SUSTAINABLE RAIL

# The Development of Modern Steam 2: *Argentina* - Porta's First Locomotive

**W. Hugh Odom, P.E. & Martyn Bane**

**Edited: Wolf Fengler, MSME, Shaun T. McMahon & Davidson Ward**

## About the Coalition for Sustainable Rail

The Coalition for Sustainable Rail (CSR) is dedicated to the refinement of solid biofuel technologies for use in the world's first carbon-neutral higher speed locomotive. Our team is a combination of the University of Minnesota and Sustainable Rail International (SRI), a 501c(3) nonprofit dedicated to the research and development of modern steam locomotives. A scientific and educational organization, CSR's mission is to advance biofuel research and production; to research and develop sustainable railroad locomotives; to promulgate associated sustainable technologies; and to support and conduct non-partisan educational and informational activities to increase awareness of sustainable railroad locomotives.

## About CSR's White Paper Program

Working in conjunction with the University of Minnesota (U of M), the Porta Family Foundation, and other not-for-profit rail and biomass research organizations, CSR's White Paper Program is bringing works pertinent to biofuel, modern steam locomotive and transportation research into the public discourse.

**Cover Image -** *This water color by artist Robin Barnes depicts locomotive "Argentina" in active service, showing in striking color the paint scheme and design of the innovative, advanced steam locomtoive.*

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## Foreword

Dear Reader:

For those who have read the CSR website or are familiar with the development of Modern Steam, they will recognize the name Livio Dante Porta. Through a collaboration with the Porta Family Foundation and Archives, CSR is excited to bring information about the genius of Porta to the public.

Ing. L. D. Porta is well-known to modern steam locomotive enthusiasts around the world. Born in 1922 in Paraná, the capitol of Entre Rios Province of Argentina, Porta grew up around railways. Porta read about locomotive design around the world in a variety of railway magazines at the Central Argentine Railway where his father worked. These magazines introduced him to new ideas and concepts and showed him the diversity of locomotive design practices around the world. Beginning in 1936 (at the age of only 14), Porta worked as a fireman, gaining practical experience on steam locomotives. Porta's experiences and observations led him to his "holistic" approach to steam locomotive design and operation.

Porta attended the National University of Litoral, Rosario and graduated at the age of 24 in 1946 with a degree in civil engineering, the only engineering major available at the time. After graduation, Porta educated himself in other engineering fields such as the mechanical design and thermodynamics necessary to further his interest in steam locomotives.

Early on, Porta became interested in the work of French locomotive designer André Chapelon who had great success improving the efficiency and power of steam locomotives beginning in the 1920's [see CSR White Paper THE DEVELOPMENT OF MODERN STEAM 1: ANDRE CHAPELON AND HIS LOCOMOTIVES].

Porta began corresponding with Chapelon in the 1940's, a communication stream that continued until Chapelon's death in 1978. Through those discussions, Porta became interested in performing similar advanced steam locomotive research in Argentina and soon located a candidate locomotive, about which this paper is written.

As with the other White Papers, these educational resources are provided to you, the public, free of charge as part of the mission of CSR. If you enjoy what you read, please share it with your friends and, if so-moved, consider making a donation to our 501c(3) not-for-profit - **www.csrail.org/support**

Sincerely,

**W. Hugh Odom, P.E.**
*Technical Advisor*

## Summary:

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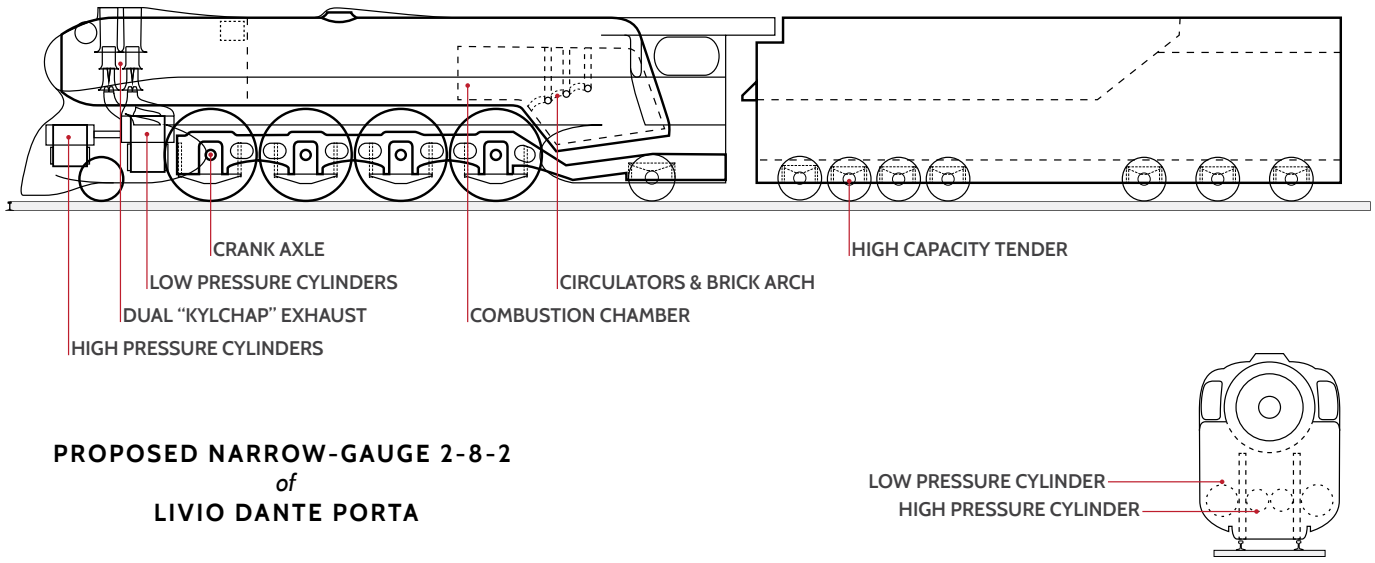
**The B22-Type Locomotive** *was used by Porta as the basis for locomotive "Argentina." When comparing this photograph with that of the finished locomotive, it is difficult to draw a physical comparison between the two. With CSR Project 130, however, much of the original locomotive shall remain in place (given it is a much more advanced base locomotive) than in Porta's work with "Argentina".*

## 1. The Locomotive

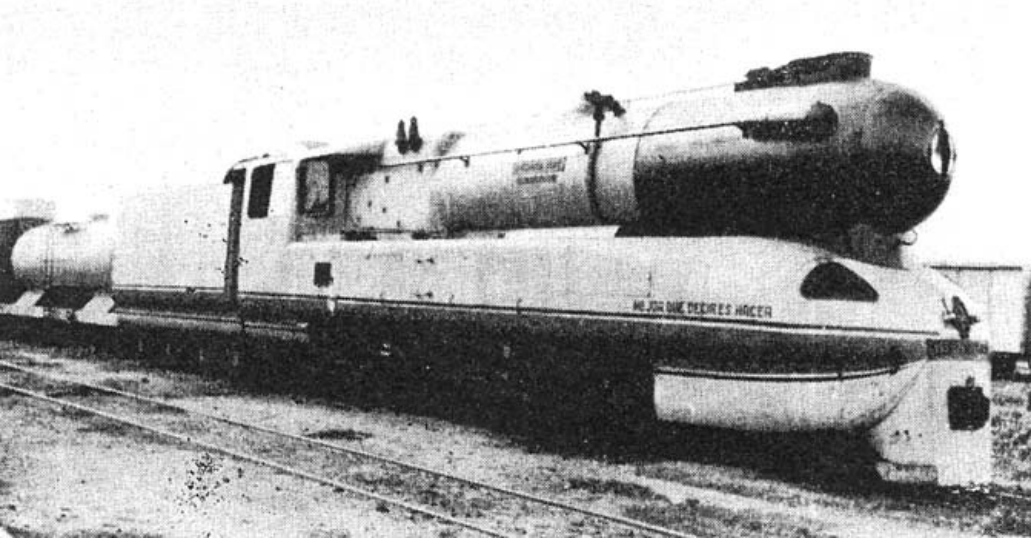
Initially, Porta considered building a new 2-8-2 locomotive, but after further consideration it was decided it would be cheaper and easier to rebuild a locomotive. The locomotive chosen by Porta for this project was a meter gauge mixed traffic (freight and passenger service) locomotive, built by North British Locomotive in Glasgow, Scotland in 1906. The locomotive came from the Ferrocarril (railway) Central Córdoba, and was class B22 4-6-2 No. 2011.

Prior to work beginning Porta had to secure funding for the project. This funding was obtained from *Banco Nacional de Desarrollo* (BANADE- the National Development Bank of Argentina). Ing. Cappa was the Minister of Economy at the time, and it was through him that Porta was introduced to Argentina's new president, Juan Domingo Perón. One of Perón's goals was to increase Argentina's economic independence; development and production of a modern locomotive in Argentina fit with this philosophy. Porta's contacts were beneficial in obtaining the funding for the project. Cappa went on to oversee the building of the Rio Turbio line (where Porta later worked) and was later President of the *Asociación del Congress Panamericano de Ferrocarriles*.

Construction of the locomotive was accomplished at "Ing. Livio Dante Porta & Co. Ltd.'s workshops at Puerto de Rosario" (Port of Rosario, approximately 300km north west of the Argentine capital Buenos Aires), Santa Fe province, from 1947 through 1950. Porta was assisted by a team of engineers and craftsmen.




**This Design for a Narrow Gauge 2-8-2** *by L.D. Porta provides a glimpse into the mechanics behind "Argentina." Both designs share the same arrangement of cylinders, exhaust, crank axle and firebox system.*



**The Locomotive in Service** *was quite a sight to see, especially considering how it began its life. "Argentina" is shown here with both its primary and auxilliary tender attached. With a rudimentary "Gas Producer Combustion System," the locomotive operated relatively smoke-free as evidenced in the test video and photographs.*

The rebuilt locomotive followed similar lines to Chapelon's rebuilds of Paris-Orleans Railway 4-6-2's into 4-8-0's (240P class), and included the following features, most based on Chapelon's work:

- Conversion from 4-6-2 to 4-8-0 to increase adhesive weight (weight on driving wheels available for traction).
- High pressure boiler (285 PSI, close to the then-current state-of-the-art for fire tube locomotive boilers). The boiler was of all-welded construction, apart from a riveted seam on the main barrel.
- 4 compound cylinders (2 high pressure between the frames, 2 low pressure outside of the frames).
- Large steam passages and ample steam chest volume.
- Belpaire firebox with depressed crown (first application of this innovation) and T-type "safety" circulators.
- Numerous secondary air admission tubes above the firebed. These in combination with the use of a thick firebed constituted the first steps toward the GPCS which Porta later developed.
- Superheating and re-superheating between the high pressure and low pressure cylinders, an innovation used previously by Chapelon on his 160A1 experimental locomotive.
- Feedwater heater.
- Dual Kylchap exhaust, the most efficient exhaust system then-available.
- Air Brakes.
- Increased coal capacity in tender with a separate auxiliary water car providing increased operating range.
- Extensive use of welded fabrication using mild steel plate.
- Designed to be capable of operation at 120 kph (~75 MPH).
- 16,000 kg (35,274 lbs) starting tractive effort.
- Complete exterior streamlining. Streamlining reduced power loss due to aerodynamic drag; this was not insubstantial even at "only" 75 MPH.
- Painted blue and white, the colors of the Argentine national flag.
- The locomotive was initially named Presidente Perón, and fitted with nameplates (not paid for by the loan). The locomotive was renamed to Argentina after Perón was removed from power during a military take-over on September 16, 1955.

**Comparative Technical Specifications**

| Locomotive | HP Cylinders | LP Cylinders | Driver Diameter | Boiler Pressure | Firebox Grate Area | Firebox Volume | Locomotive Weight | Adhesive Weight |
|---|---|---|---|---|---|---|---|---|
| B22 | 475x560 mm | - | 1270 mm | 1265 kPa | 2.13 m2 | unk. | 54 mTons | 35.8 mTons |
| | 18x22 in | - | 50 in | 183 PSI | 23 ft2 | unk. | 59 Tons | 39.5 Tons |
| *Argentina* | 360x660 mm | 580x560 mm | 1270 mm | 1962 kPa | 3.9 $m^2$ | 8.5 $m^3$ | 69.1 mTons | 54.9 mTons |
| | 14.2x26 in | 23" x 22 in | 50 in | 285 PSI | 42 $ft^2$ | 200 $ft^3$ | 68 Tons | 54 Tons |

## 2. Testing and Operations

With its complete streamlining and blue and white paint job, the locomotive struck an impressive appearance. After initial "teething" problems with steam leakage were corrected, testing of the locomotive began using the railway's dynamometer car.

> *Several tests were undertaken with very heavy goods trains. It should be noted that these trains were loose coupled – that is, there were no continuous brakes fitted! The only brakes which could be applied in motion were those on Argentina and the guard van. A 1219 metric ton (1200 ton) train was hauled with ease at up to 105km/h (65mph) whilst a 2032 metric ton (2000 ton) train was taken at 80km/h (50mph).*

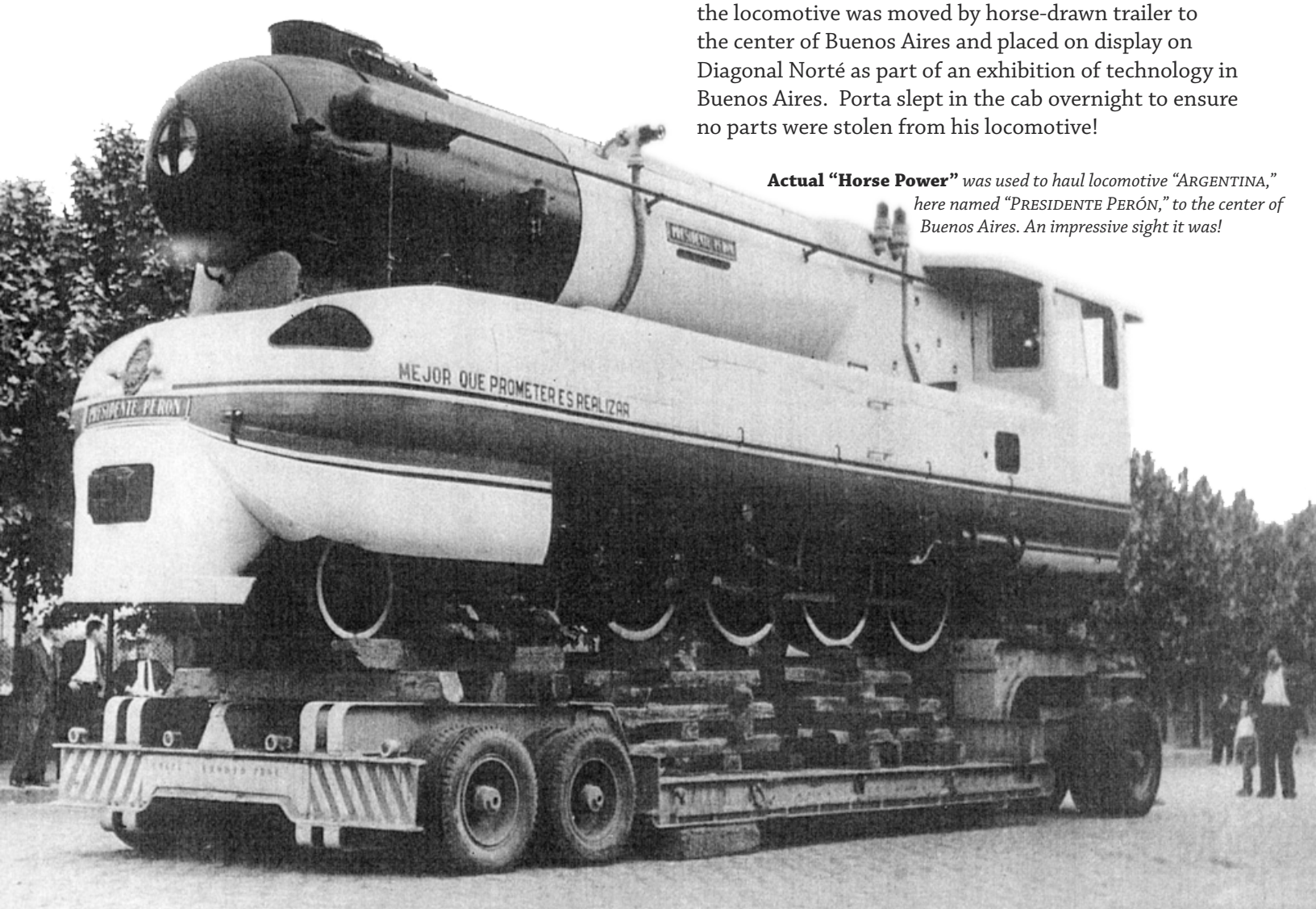
Porta stated that due to poor condition of mainline track and draw gear on railway cars in Argentina at the time, it was not possible to work the locomotive to its full capacity due to trains repeatedly parting. As a result, the locomotive's true maximum power was never measured. A very interesting video surfaced in recent years showing the locomotive in operation on a test train, with appearances not only by Ing. Porta himself, but also his friend and mentor André Chapelon, on a visit from France. (see "References" section for Youtube URL").

Amazingly, *Argentina* achieved world records for power-to-weight ratio and thermal efficiency for steam locomotives up to that time. The power output was nearly triple the estimated 700 horsepower the original locomotive could produce. In 1949 or 1950, the locomotive was moved by horse-drawn trailer to the center of Buenos Aires and placed on display on Diagonal Norté as part of an exhibition of technology in Buenos Aires. Porta slept in the cab overnight to ensure no parts were stolen from his locomotive!

**Results from Testing**

| Maximum DB Power | Power:Weight Ratio | Specific Fuel Consumption | Drawbar Thermal Efficiency |
|---|---|---|---|
| 1,581 kW (2,120 HP) | 23.2 kW/T (31 DBHP/T) | 0.3 kG/MJ (1.78 lb/DBHP) | 11.9* |

* Estimated drawbar thermal efficiency would have risen to 13% if it had been measured at a power and speed corresponding to the maximum drawbar thermal efficiency.




**Actual "Horse Power"** *was used to haul locomotive "Argentina," here named "Presidente Perón," to the center of Buenos Aires. An impressive sight it was!*

## 3. Later Years

The chief result of the successful performance of *Argentina* was that Porta's work was vindicated. A contract was awarded to Ing. Porta's company to make modifications to numerous steam locomotives of the 5'6" gauge Ferrocarril General Roca (FCGR) suburban rail network (formerly the Buenos Aires Great Southern Railway). These locomotives were used in commuter train service, and Porta was able to improve their performance significantly through relatively-minor modifications.

Meanwhile, *Argentina* was placed into freight service. The impressive streamlined casing on the locomotive inhibited maintenance efforts and was later modified to improve access as much as possible. The locomotive remained in freight service until about 1961 by which time it had accumulated 70,000 km (43,500 miles).

Unfortunately, after this, the locomotive was dumped at La Plata depot from 1961 until the mid-1970's. At some point Argentina was moved to Tafí Viejo, the site of the country's largest meter gauge railway equipment factory. Here it remained in storage until a cultural initiative in nearby Tucumán city, the provincial capital of the Province of Tucaman, turned the Norte (North) railway station into a Transport Museum in 1996. The museum contained several locomotives and vehicles

**Forlorn and Vandalized** *This picture from 2010 shows the current state of "Argentina." While it is a sad sight, the view provides a clear look at the frame and tube arrangement of the locomotive.*

from the region but the real star was *Argentina*. Prior to being placed on exhibit [left], the locomotive was painted dark gray and placed on exhibition with passenger coaches alongside one platform.

In the year 2000, Porta made plans to locate and stabilize the locomotive. Later he planned to rebuild it as a practical steam demonstrator project, removing all the faults it contained. The locomotive was to be rebuilt by the next generation of steam engineers, becoming a learning tool and test bed for new ideas and a learning tool for the next generation. Unfortunately, the world-wide economic downturn in 2001 killed the chances for the project. The museum soon closed, and the locomotive was left unprotected in what became a largely lawless area. A concerted effort was made to raise funds to rescue Argentina and move it to a safe location for restoration and display, but this effort failed.

Sadly, the locomotive was effectively scrapped in place by metal thieves over the next few years. The most recent photographs of the remains of the locomotive show that only the frames, cylinders, and boiler remain partially intact. Like Chapelon's great locomotives before it, *Argentina*'s significance was not recognized by its homeland and it was tragically not preserved for future generations.

## 4. Conclusions

The story of *Argentina* shows the incredible drive of a young, very industrious engineer in successfully conceiving, coordinating, financing, designing, building and testing a very modern steam locomotive. Virtually every known thermodynamic improvement available at the time was applied in its construction. The locomotive set world records for thermal efficiency and power-to-weight ratio for steam locomotives.

Despite its success, *Argentina* was not well-suited for railway conditions in Argentina at the time and mainly served as a rolling test lab. *Argentina* did serve to show how the classical steam locomotive could be significantly improved, which led to contracts for Porta's company to perform other locomotive modifications in Argentina.

This success began Porta's life-long career in improving steam locomotive performance. There were many reasons locomotive *Argentina* did not lead to a generation of new modern steam locomotives in Argentina. Chief among these reasons was Argentina's political situation. The military government which deposed Perón joined Argentina to the International Monetary Fund which provided low interest loans for the purchase of new diesel locomotives.

Additionally, Porta's company fell out of favor with the military government as the company was associated with the Perón era which was no longer "allowed to have existed".

*Argentina* was the first and the most comprehensive rebuild project accomplished by Porta, and was the beginning of a long line of successful ventures by Ing. L. D. Porta and his successors that led directly to the developments of the Coalition for Sustainable Rail.

**A Few Men and a Dog** *are shown here in this promotional photograph of Argentina. Which member is L.D. Porta? The jury is still out, but S. McMahon believes it could eiher be the gent on the top of the locomotive in the Fedora or the goggled man in the fireman's seat. The dog's name is unknown.*

## References


1) My Difficulties- L. D. Porta

2) *XXIst Century Steam, the Day of Modern Steam Traction- L. D. Porta*

3) *Martyn Bane webpage*

4) Steam Locomotive Development in Argentina- L. D. Porta

5) http://www.youtube.com/watch?v=07r0t2tFCqE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