The T1 Trust

2018 ASTT Conference

29-30 September, Bury Transport Museum
5550 Engineering Update

- Research Progress
- Summary of Design Changes Planned
- CAD model Status
- Construction Progress
- Part Acquisition
- Next Steps
Total T1 list increased from 1,856 to 1,872
- Obsolete drawings superseded by new drawings
- Drawings found that were not on original tracing list.

To maintain the project schedule we would have to acquire 370 drawings per year average.
- May 2018 target – 1,628
- May 2018 actual – 1,858

14 drawings left to find

41.5 total research days
- 3 days 2014
- 14.5 days 2015
- 16 days 2016
- 5 days 2017
- 3 days so far in 2018

1,642 scanned from linen tracings
215 From Microfilm
T1 Drawing Set - PRR

Tender – 98.9%
- Airbrake – 100%
- Draft Gear – 100%
- Coal gates – 100%
- Frame – 100%
- Radial Buffer – 100%
- Front End Sill – 100%
- Feedwater Heater – 100%
- Rear End Sill – 100%
- Lighting – 100%
- Communication – 100%
- Marker lights – 100%
- Center light – 100%
- Lettering – 100%
- Pipe Fittings – 100%
- Pipe Clamps – 100%
- Steam Heat – 100%
- Stoker – 100%
- Tool Equipment – 100%
- Tank – 98%
- Tank Valve – 95%
- Water Level Indicator – 100%
- Tool Closets – 100%
- Water Scoop – 97%
- Truck 4F5T1 – 100%
- Timken Bearings – 100%
- SKF Bearings – 95%

Locomotive – 99.3%
- Airbrake – 97%
- Driver Brake – 100%
- Ash Pan – 100%
- Boiler – 99%
- Boiler Fittings – 100%
- Cab Fittings – 100%
- Cab – 99%
- Cocks and Valves – 98%
- Cylinder – 100%
- Driving Gear – 100%
- Fire Door – 100%
- Frame – 100%
- Grates – 100%
- Headlight – 100%
- Cab Lighting – 100%
- Lettering – 100%
- Lubricator – 98%
- Pilot – 100%
- Piping – 100%
- Pipe Clamps – 92%
- Pipe Clamps – 92%
- Running Boards – 100%
- Running Gear – 100%
- Reverse Gear – 96%
- Smokebox – 100%
- Steam Pipes – 100%
- Whistle – 100%
- Stoker – 100%
- Streamlining – 100%
- Superheater – 97%
- Throttle Rod – 100%
- Throttle – 100%
- Trainphone – 100%
- Engine Truck – 96%
- Trailing Truck – 100%
- Valve Gear (Type A) – 100%
Design Changes

Changes that will be implemented:

- Incorporate Drive Arm Supported Franklin Type B2 poppet valve gear
- Welded Boiler, with revisions to meet FRA Form 4 Requirements.
- Lateral motion control devices added to #2 axle to satisfy FRA Regulations
- Cab glazing will be replaced with “bulletproof” glass per FRA Regulations
- Airbrake equipment will be updated from 24RL to modern components.
- Engine and Trailing Truck Bearings will be replaced with COTS units.
- Add Diesel MU capability.
- Trainphone will be replaced with modern radio, data recorders and PTC
- Delete water scoop and add connections for auxiliary tender.
- Add wheel slip alarm.
Possible Changes

Changes that will likely be incorporated, but still have details undefined:
- Revise frame from integral cast single piece design to weldment
  - Split frame into 2-3 smaller castings (bed, separate engines)
  - Driven by complexity/cost risk of single piece casting not size limitation
- Replace Hancock feedwater heater with Worthington SA or Elesco model, or Union Pacific-style steam injector

Changes that are being investigated for incorporation into the final design:
- Conversion to oil firing / renewable fuel.
  - Addition of overfire air jets to firebox
  - Addition of wheel slip control system
    (complex, difficult to integrate into existing package)
  - Incorporate Kylchap / Lempor style exhaust
    (consider the original draft arrangement as shown in the next slide)
Features

- Twin Kiesel “Star” exhaust nozzles
- Straight-sided oval petticoat
- Master Mechanics spark arresting gear, modified
46 parts modeled, 36 drawings referenced, 592 total parts in assembly.

Progress stalled due to lack of manpower. Available resources focused on archives extraction.

Modeling work on engine and trailing trucks to begin this year.

CAD models created by outside suppliers not yet received for incorporation in main model.
Cab CAD Modeling

- CAD model created by Jaktool in Solidworks during 2017
- Outer Shell only – no doors, windows or ventilators

1 - Dwg. No. A433567 – Cab Plan and Elevation

2 - Dwg. No. A433568 – Cab Front and Back Sections

3 – Image of 3D model
Frame CAD -2017

Dwg. No. A433653 – Frame Arrangement

- CAD image at left represents area highlighted in yellow on drawing.
- 2 Separate, equally complex drawings for each cylinder detail.
  - A433654 – Front Cylinder
  - A433655 – Back Cylinder

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CAD image below represents area highlighted in yellow on drawing.
Boiler CAD Model

CAD Assembly of existing part models – Created by Trust Member Wolf Fengler.

- Contains 1st/2nd and 3rd courses, dome, dome lid, Front and rear tube sheet, Hip Sheet
- 104 man-hours of CAD time to date on Welded Boiler.
- Riveted boiler will also be modeled to compare weight.
Steam Dome is a standard forged item used in oil and gas industry, rather than a custom formed plate – cost savings.

3rd Course is split into 2 pieces (top & bottom) rather than single piece for ease of forming.
Steam Dome Comparison

PRR Drawing D429983 – Detail of Dome

Revised Dome

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Dome Lid Comparison

PRR Drawing E429980 – Dome Lid.

Revised Dome lid.
Boiler Drawings – Rear Flue Sheet

- 69 Superheater Flues (same as original)
- 180 Tubes (vs. 184 original – 2.2% loss in tube area, 0.75% loss in total heating surface)
- Loss of tubes resulted from larger bend radius of 5/8” sheet (original is 9/16” - thickness not available)
- Slightly different tube arrangement.
- Need to increase total heating surface by 40 sq-ft to offset tube area loss.
Rear Flue Sheet Comparison

- Tube bundle shifted upward slightly.
- Decrease in tube count on sides of boiler.
- Addition of tubes below superheater flues.
- If changes not made, total tube loss would have been 14 (7.6% loss in tube area, 2.6% loss in total heating surface).
- Additional 147 sq-ft needed to offset loss.

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Boiler 1st, 2nd and 3rd Courses

- Single Original Course replaced with 2 smaller courses due to material availability (max sheet is 6” too short).
- Fabrication work performed at Continental Fabricators Inc. of St. Louis, Missouri
- Includes rolled courses and clean outs, welding, X-ray inspection, stress relief.
- 1” thick, 93 ½” OD (vs. 7/8” thick, 91 ½” OD original)
- Front flue sheet currently being engineered; will feature easily replaceable tube sheet
Boiler Rear Flue Sheet

1 – Gary Bensman cuts blank from 5/8” plate... and lays out centerlines (2)

3 – Blank is placed in McCabe Flanger at TVRM

4 – Forming Underway

5 – Flanging Complete

6 – Jason Johnson and crew perform final shaping by hand.
Other Components

- 2 Main Driver Centers
- Streamlining Prow Complete
9 – Cab with front panel, window support structure added
10 – Cab remaining sheetmetal added
11 – View aft from firebox

12 – Cab Ladders

13 – Fireman’s side rear view showing jump seat alcove
P RR 210F75A tender
- Originally assigned to M1 # 6659, last used as oil tank for Diesel servicing.
- Purchased from Western NY Railroad Historical Society

Conversion to 180P84 tender
- Estimate $3M savings over building from scratch.
210F75A vs. 180P84

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Stoker

- Trough, Gearbox, Coal Crusher, Motor & Reversing Valve.
- All components needed to complete Tender.
- Donated by Gary Bensman and Warren Lathom.
NEXT STEPS
Multi-stage activity:

1. Continue Solidworks CAD model of original cast frame.
2. Analyze baseline model for stiffness, strength, durability
3. Design equivalent weldment to replace once piece casting
4. Validate new design for equivalent performance to baseline
3rd Course and Front Flue Sheet

- Dome fabrication pending
- In Process

At least one of 2nd Pair of Main Driver Centers:

Other parts as opportunities arise.
THANK YOU!
The Pennsylvania Railroad T1 Steam Locomotive Trust, Inc.

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