CALIFORNIA
High-Speed Rail Authority

REPORT

Update to Peer Review Group of work in progress on Train Performance Calculation (TPC) Trip Time Analysis

San Francisco
July 9th

FINAL

Train Performance Calculations – Key Take-Aways

- System being designed to achieve Prop 1A trip times (Sec. 2709.9) as demonstrated with TPC model runs (see pages13-15)
- Trip Times are based on the use of current technology and may improve when the system becomes operational as technology advances
- The Berkley Simulation model, RTC is a proven simulation tool used by the Class 1 freight railroads, many commuter railroads and the FRA
- Current alignments are only designed to the 15% level and they will evolve as we go through the environmental process
- The Authority focus on system trip time will continue throughout the project; new baselines will be issued concurrent with Environmental milestones and Authority Business Plans

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The California High-Speed Rail has to be designed to achieve overall performance in accordance with Prop 1A

- California Proposition 1A (2008) : "The High Speed Rail System… shall be designed to achieve the following characteristics: ….(b) Maximum non-stop service travel times for each corridor that shall not exceed the following:"
  - San Francisco-Los Angeles Union Station: two hours, 40 minutes.
  - San Francisco-San Jose: 30 minutes.
  - San Jose-Los Angeles: two hours, 10 minutes.
  - San Diego-Los Angeles: one hour, 20 minutes.
  - Inland Empire-Los Angeles: 30 minutes.
  - Sacramento-Los Angeles: two hours, 20 minutes
- Train Performance Calculation or TPC analysis, is part of an on-going process
- The analysis is and will be performed so that the alignments proposed by the CHSTS regional teams can be focused to achieve overall system design in accordance with Prop 1A
- The TPC's are "snap-shots" of evolving alignment options that will solidify when the RODs from the environmental efforts are completed for each section.

TPC's are a feature of the Authority's Train Simulation Tool

- Trip time was calculated using the train performance calculation (TPC) feature in Rail Traffic Controller (RTC) railroad operations simulation model, developed by Berkley Simulation Software (BSS)
- RTC is capable of performing the various analysis required for the railroad operations planning and analysis, including:
  - TPC: Simulating train performance based on trainset/consist and track/infrastructure characteristics
  - Dynamic Simulation: Simulating train movements at corridor-wide/network-wide level using TPC outputs and built-in dispatching logic
- RTC provides for a broad portfolio of customizable features that makes it possible to replicate a wide range of operations planning/analysis scenarios under various operating conditions: passenger-only, freight-only, and/ or mixed-traffic condition
- Because of these features, RTC is widely used in railroad operations analysis and planning in the United States by entities, including but not limited to:
  - Class I freight railroads (i.e. UPRR, BNSF, NS, CSX, KCS)
  - Passenger rail operators (i.e. Amtrak, regional/commuter rail operators)
  - Federal agencies overseeing the railroad transportation and funding (i.e. STB)

Track infrastructure and rolling stock profiles are required model inputs

- Following characteristics need to be accurately replicated in RTC model in order to perform TPC trip time analysis
  - Track Infrastructure Profile
    - Track/Infrastructure Inputs
    - Track geometry
    - Horizontal curve profiles
    - Vertical curve profiles
    - Civil Speed limits
    - Platform locations
  - Rolling Stock Profile
    - Weight
    - Length
    - Braking characteristics
    - Tractive and braking effort
    - Rolling resistance

Infrastructure inputs are based on a 250 MPH design

- Although no assumption are made for operating speeds in excess of 220 MPH, the system is being designed to handle operating speeds of 250 MPH over much of its length. This will provide an opportunity to improve trip times and keep pace with technological improvements as the system grows.
- Track/infrastructure profiles coded into the RTC model for CHSTS TPC trip time analysis accurately replicate the latest profiles provided by the CHSRA Regional Consultants
- Direct numeric output from the CADD drawings for each alignment alternatives were used as an input and coded into the model
- The track/infrastructure profiles coded into the model were then spliced into one network to create the system-wide network on the RTC model
  - Assumed preferred alignment combinations were chosen by the CHSRA Regional Consultants and the PMT Regional Managers
  - Match points for these individual alignment alternatives were selected in the engineering drawings and carefully reviewed as per established protocols after being spliced together

On many segments several alignment alternatives are still under consideration

- Alignment combinations, as presented here, were used in the TPC trip time analysis
- The combination shown is the one based on the information used in the CHSTS 2012 Revised Business Plan
- Caltrain has performed simulations of the "blended service" on their corridor in a mixed use environment. Their simulation plan did not call for operation of a SF to SJ express trains
- Caltrain TPC runs for express trains between San Francisco and San Jose confirmed run times as calculated by the Authority

Segment	Alignment	Length (ft)	Length (mile)
San Francisco to San Jose*	Existing Caltrain alignment plus curve modifications to achieve targeted operating speeds	252,597	47.5
San Jose to Wye	SR-87 to I-280	9,438	1.79
	Refined Program	46,185	8.75
	East of UPRR to Downtown Gilroy	171,049	32.40
	PP-close prox to 152	124,834	23.64
	HM to Ave 24	175,323	33.21
Wye to Fresno		186,565	35.33
Fresno to Bakersfield	F1	53,384	10.11
	M	43,482	8.24
	H	107,956	20.45
	K4	50,304	9.53
	C2	52,489	9.94
	P	36,325	6.88
	A1	100,644	19.06
	L2	44,393	8.41
	WS2	76,499	14.49
	B3	63,110	11.95
Bakersfield to Palmdale		406,295	76.95
Palmdale to Los Angeles (Union Station)	SR 14 EW-H1.3	121,192	22.95
	SCS 2.0	82,235	15.57
	BSS 13.3	85,999	16.29
	L1C 12.2	33,849	6.41

We looked at various existing rolling stock technologies capable to operate at speed of 220 mph

- Since the decision for fleet purchase of high speed rail rolling stock has not been made it was necessary to emulate a existing design that had the capability of operating at 220 MPH.
- Alstom Automotrice à Grande Vitesse (AGV) was used as the representative rolling stock technology utilized in TPC's
- Alstom AGV is a high-speed electric multiple unit (EMU) with the following features:
  - Designed maximum operating speed of 220 MPH
  - Variable trainset/consist length, from 7-car long up to 14-car long
    - An 11-car, 660-ft consist was assumed for CHSTS trip time analysis

Trip times are based on the use of current technology

- The rolling stock profile was coded into the RTC model based on the specifications provided by rolling stock manufacturer, in this case Alstom
  - Basic "catalog" specifications, such as weight, length, and consist configuration are entered
  - Tractive and braking effort curves: available force at every speed from zero to maximum
- Once the rolling stock profile was input on the RTC model, the obtained performance characteristics were validated by Alstom and confirmed.
- The rolling stock profile does not assume any technological improvements in trainset design for acceleration or braking characteristics that would result in better train performance and trip time. Simulations were confined to the current generation of high speed equipment

TPC outputs provide train performance and run time characteristics

- TPC outputs provide the following operational characteristics of the trip (called a "run") as specified in RTC model
  - Speed of the train, at any given moment/location of the run
  - Throttle/Brake positions, at any given moment/location of the run
  - Target speed of the train, including speed limits defined by track geometry and alignment, at any given moment/location of the run
  - Distance from the start of the run
  - Pure run time from the start of the run
  - Trip time purely based on the train performance characteristics with no pad or buffer time is included. This is called the "pure run time"

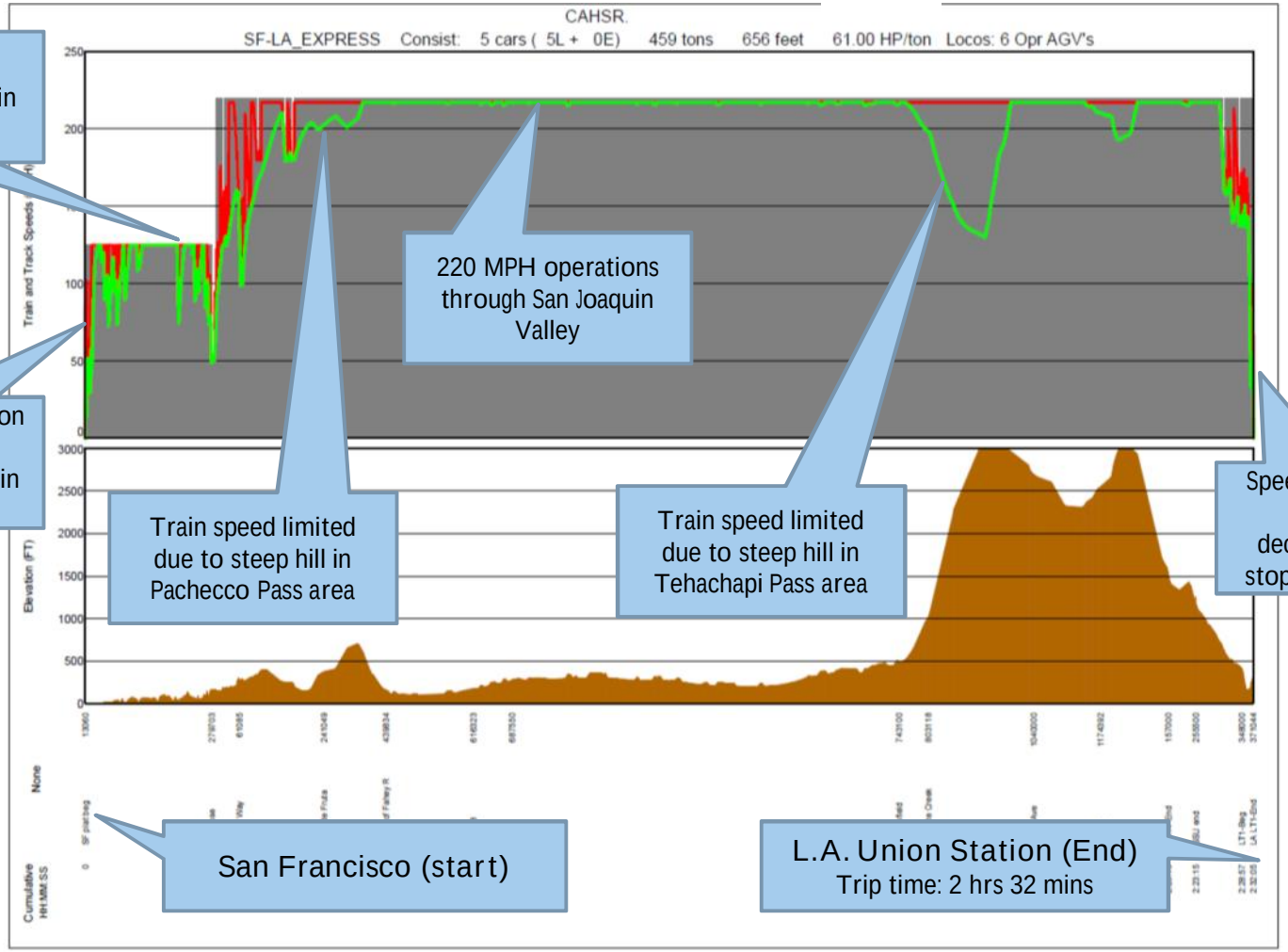
TPC's results show that Prop 1A run time requirements can be achieved

- TPC's for the alignments used in the 2012 Plan showed a "pure run" time of 2 hours and 32 minutes between San Francisco and Los Angeles
  - See results pages 13 & 14

- San Francisco to San Jose run time also meets Prop 1A 30 minute requirements
  - See results page 15

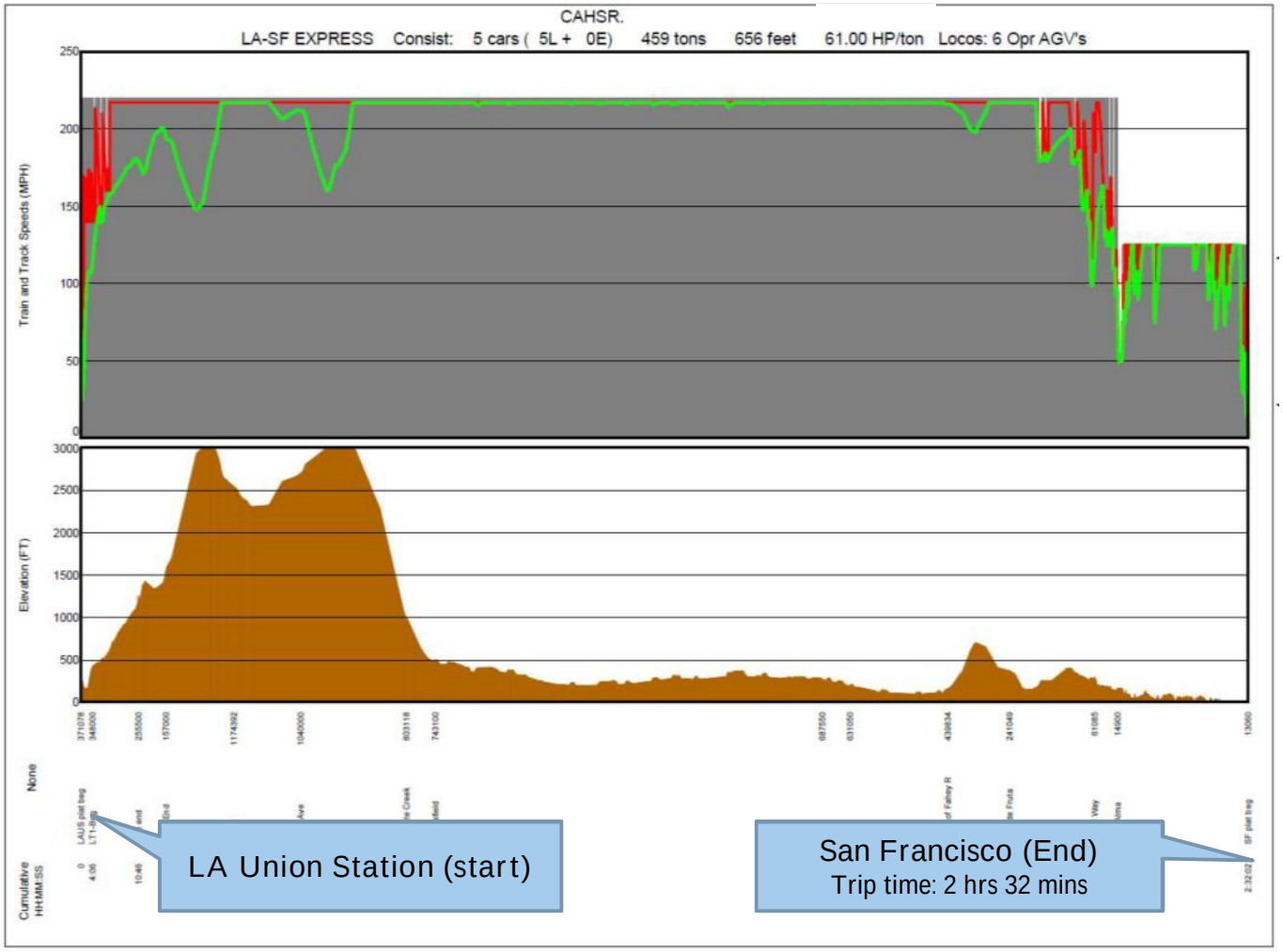
TPC's for the alignments used in the 2012 Plan showed a "pure run" time of 2 hours and 32 minutes (SF – LA)

CHSTS TPC Trip Time Analysis Result SF-LA (Southbound) Non-Stop Run



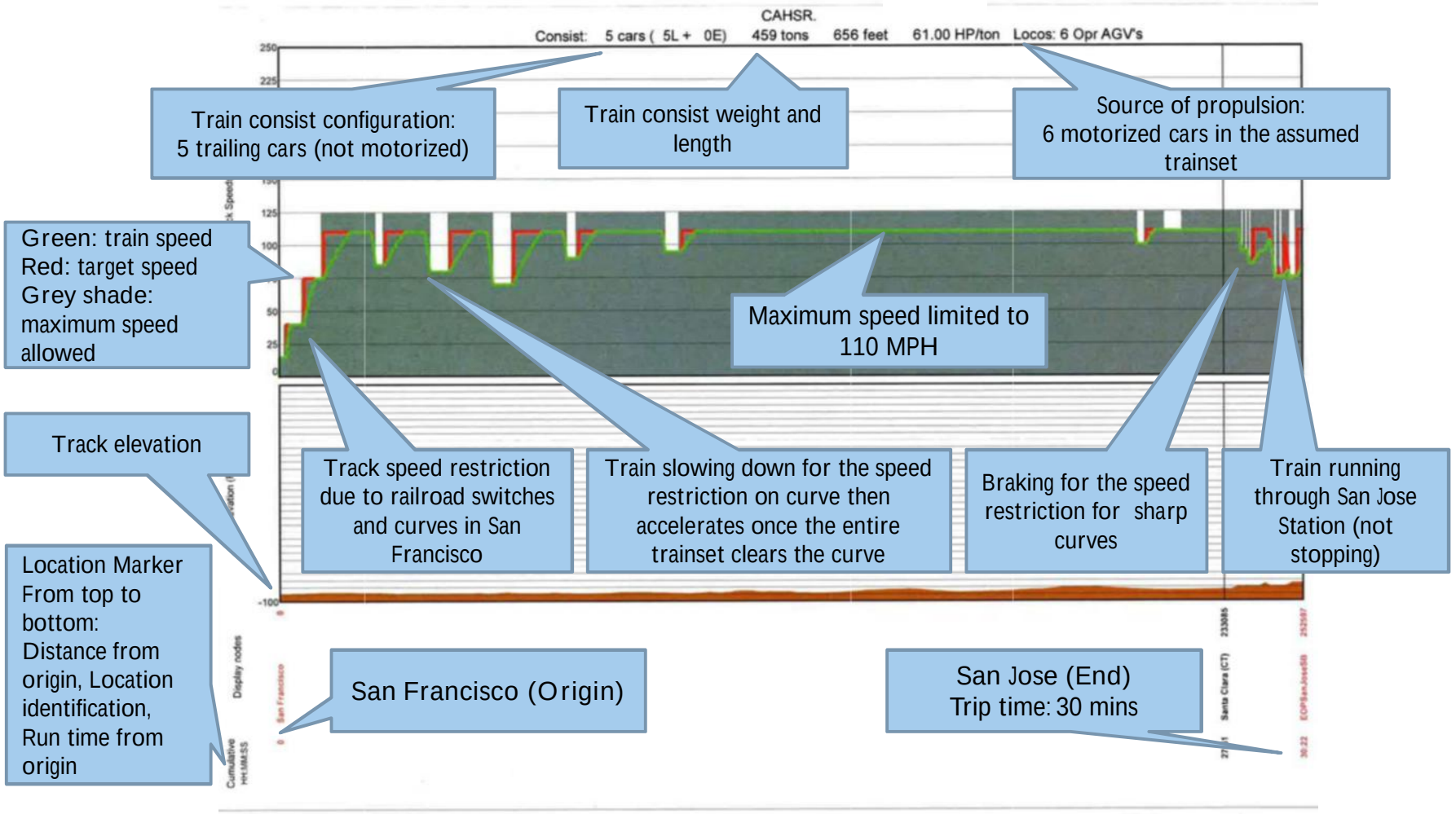
We ran the reverse trip to validate trip times are also achieved in the opposite direction

CHSTS TPC Trip Time Analysis Result LA-SF (Northbound) Non-Stop Run



San Francisco to San Jose can be achieved with a 30 minute trip time

CHSTS Caltrain Corridor Non-Stop Run at a Maximum Authorized Speed of 110 MPH



Future TPC's simulations...

- New TPC system simulations will be run and will be coordinated with future environmental ROD's and High Speed Rail Authority Business Plans