DESIGN SOLUTIONS FOR THE SOUTH TRI-STATE TOLL HIGHWAY (M.P. 0 TO M.P. 3.6)

AUGUST 13-16, 2006

SPONSORED BY TRB COMMITTEES – ADA70, AFB10, AHB65

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7TH NATIONAL ACCESS MANAGEMENT CONFERENCE

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  - Subhas Bose
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- Contributing Authors
  - Rich Hoffman
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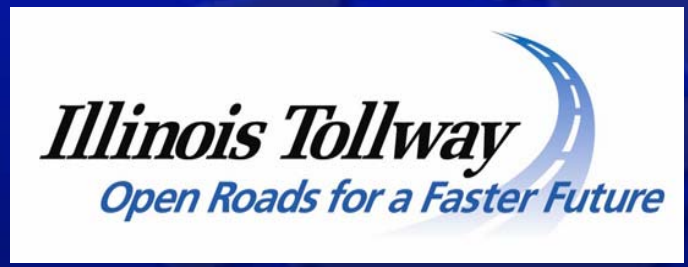

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Presentation Overview

- History
- Description
- Constraints
- Project Challenges and Solutions
- Summary

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Project History

- Contracts Awarded July 2001 to rehabilitate the pavement and bridges, much constructed in 1950s
- 3.6 miles with 2 interchanges and part of a 3rd
- Scope changed June 2002 – Reconstruction
- Construction cost estimated at $150,000,000
- Up to 50 concurrent internal staff in five offices + subconsultants

KEI

TECHKNOW Engineering

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Project Description

- Just south of Chicago near Indiana state line
- Main route between Michigan and Wisconsin through Illinois
- Section included 8 mainline bridges and 5 over crossing bridges (plus the Oasis)
- 6 lane section to 8 and 10 lane sections
- 3 existing and 2 proposed toll plazas

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Interchanges – Portion of I-294/I-80/IL394

Interchanges – Lincoln Oasis Ramps

Interchanges – Halsted Interchange

Special Project Constraints

- Maintain traffic during construction
- Concept report contracts
- Schedule and budget
- Right of way, rock, and soil
- Overhead structures to remain due to schedule and budgetary constraints
  - Decision to provide maximum benefit to the public for the available budget

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Maintain Traffic

- Minimum of 3 lanes open in each direction during construction
- 15 minute road closures for beam placement and rock blasting
- Coordination with adjacent IDOT and INDOT improvements

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Concept Report Contracts

- Various firms prepared discipline specific concepts
- Overall Design Concept overlapped individual concepts
- Explored issues made by discipline specific concepts and adapted as the design developed.

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Schedule and Budget

- Bidding by end of 2004
- Construction complete by Fall 2006
- Construction budget
- Design budget

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Right of Way, Rock, and Soil

- Urban area
- Quarry
- Forest preserve
- Poor soil at east end of project

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Overhead Structures to Remain

- 2 Railroads
- 1 Oasis
- 3 Roadways
- Meet current vertical clearance criteria

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Project Challenges and Solutions

- Mainline Profile Design and Superelevation
- Design Speed Profiles
- Maintenance of Traffic Design
- Revision of Tollway Criteria and Standard Drawings
- Barriers and Warrants
- Soils (required special design considerations)
- Design Exceptions
- Special Design and Environment

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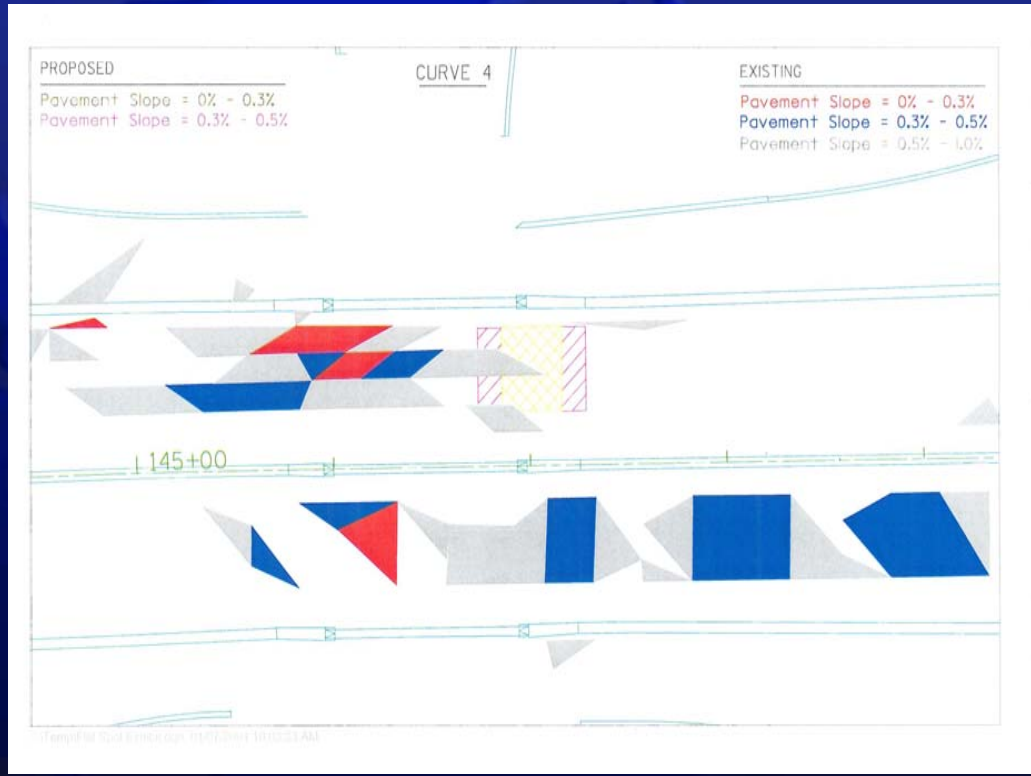
Mainline Profile and Superelevation

- Provide clearance under structures
- Footing impacts
- Provide drainage
- Consider superelevation transitions



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Design Speed Profiles

- Needed at speed adjustment locations
  - Ramps and ramp terminals
  - CDs
  - Toll Plazas
- Based on AASHTO acceleration and deceleration rates

BY MGD DATE 11/4/2003 RVSD 1/26/2004
CHKD BY DRM DATE 1/28/2004

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SHEET # ____ OF ____
JOB NO. ____

EXAMPLE RAMP DECELERATION CALCULATIONS

Profile grade	Cumulative Distance s (ft)	Station	Speed V (ft/s)	Speed V (mph)
FLAT GRADE (<2%)	-	799+00	66.0	**45.0**
	0	799+15	66.0	**45.0**
	5	799+20	65.6	**44.7**
	10	799+25	65.2	**44.4**
	20	799+35	64.3	**43.9**
	30	799+45	63.5	**43.3**
	40	799+55	62.7	**42.7**
	50	799+65	61.8	**42.1**
	60	799+75	60.9	**41.5**
	70	799+85	60.0	**40.9**
	80	799+95	59.1	**40.3**
	90	800+05	58.2	**39.7**
	100	800+15	57.3	**39.0**
	110	800+25	56.3	**38.4**
	120	800+35	55.4	**37.7**
	130	800+45	54.4	**37.1**
	140	800+55	53.4	**36.4**
	150	800+65	52.4	**35.7**
	160	800+75	51.3	**35.0**
	170	800+85	50.3	**34.3**
	180	800+95	49.2	**33.5**
	190	801+05	48.1	**32.8**
	200	801+15	46.9	**32.0**
	210	801+25	45.8	**31.2**
	220	801+35	44.6	**30.4**
	230	801+45	43.4	**29.6**
	240	801+55	42.1	**28.7**
	250	801+65	40.8	**27.8**
	260	801+75	39.5	**26.9**
	270	801+85	38.1	**26.0**
	280	801+95	36.6	**25.0**
	290	802+05	35.1	**24.0**
	300	802+15	33.6	**22.9**
	310	802+25	31.9	**21.8**
	320	802+35	30.2	**20.6**
	330	802+45	29.3	**20.0**
	340	802+55	29.3	**20.0**
	350	802+65	29.3	**20.0**

(1) Deceleration Length from 45 mph to 20 mph from AASHTO Ex. 10-73 325 FT

(2) Calculate deceleration rate used by AASHTO

$V^2=V_o^2+2*a*(s-s_o)$ (from FE Handbook)

V = Design Speed = 20mph (29.3 ft/s)

V_o = Init.Design Speed = 45mph (66 ft/s)

a = rate of deceleration

Solving for a yields,

$a = ½ * (V^2-V_o^2)/(s-s_o))$

$a = ½ * (29.3^2-66^2)/(325-0) =$ -5.38 ft/s/s

(3) Design Speed must be less than or equal to:
40mph at curve #1 PC Sta. 800+00.00
25mph at curve #2 PCC Sta. 801+95.00
20mph at curve #3 PCC Sta. 803+25.00

(4) Set up table using above criteria and deceleration rate to establish point at which deceleration begins. From above equation solving for V yields,

$V= \sqrt{[\ V_o^2+2*a*(s-s_o)]}$

(5) 25 mph control point (Sta. 801+95) will determine where deceleration begins.

(6) 25 mph control point (Sta. 801+95) is before Sta. 803+00, therefore no adjustment is required for the upgrade present after Sta. 803+25.

(7) Using the deceleration rate of 5.38 ft/s/s means that $\{29.3^2=36.67^2+2*(-5.38*S)\}$ 45.2' ft is required to decelerate from 25 to 20mph.

From Speed Control Point at Sta. 801+95
Begin deceleration at Sta. 799+15.20
End deceleration at Sta. 802+40.20

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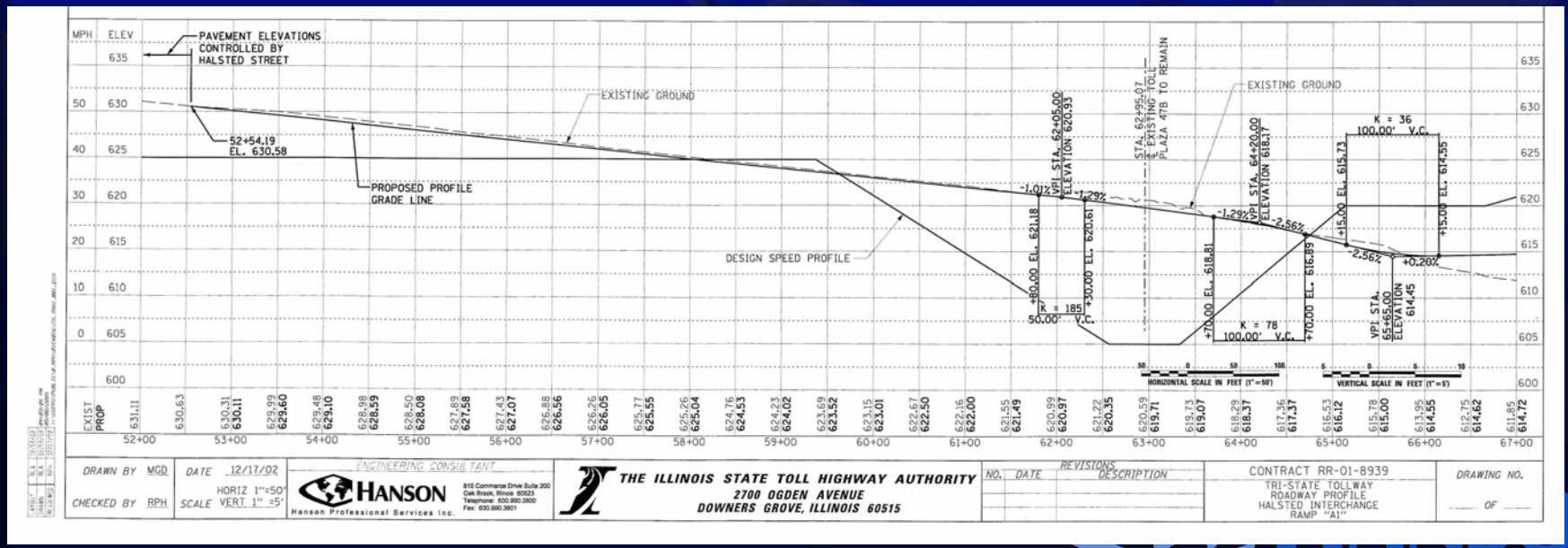
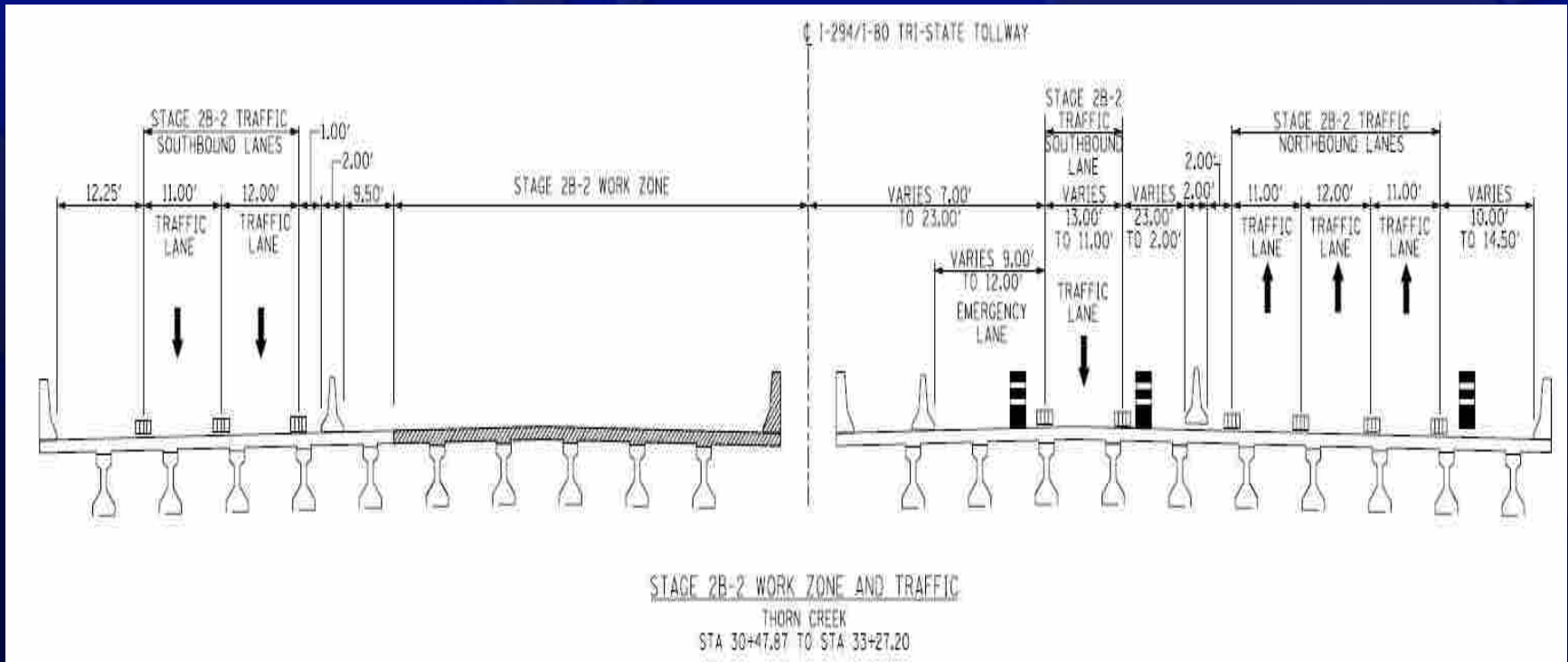
Design Speed Profiles

- Horizontal geometrics
- Vertical geometrics



Maintenance of Traffic Design

- Speed selection and superelevation
- Number of lanes
  - Mainline crossovers
  - Counter flow lanes



STAGE 2B-2 WORK ZONE AND TRAFFIC
THORN CREEK
STA 30+47.87 TO STA 33+27.20

Maintenance of Traffic Design

- Temporary signals
- Blasting
- Earthwork calculations

Year 1

Year 2

Revision of Tollway Criteria and Standard Drawings

- AASHTO 2001 “Green Book”
- AASHTO 2002 “Roadway Design Guide” (Roadside Safety Analysis Program)
- Tollway Standard Drawings under revision from 2001 to 2004
  - Understood client’s goal to incorporate
  - Identified critical standard drawings

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Barriers and Warrants

- Utilized new software for Level 3 barrier warrants (RSAP)
  - 1st consultant to use for client
  - Contacted development team
- Interesting analyses:
  - Presence of rock
    - Sign pedestal
    - Tapered rock cut
  - Kick out for a sign support
  - Cloverleaf opposing traffic and barrier options

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Design Exceptions

- Tollway has their own forms and process
- Identified up to 60 potential design deviations
  - Many eliminated
    - Modified design
    - Met other's accepted criteria / policy
  - Design speed & decision sight distance

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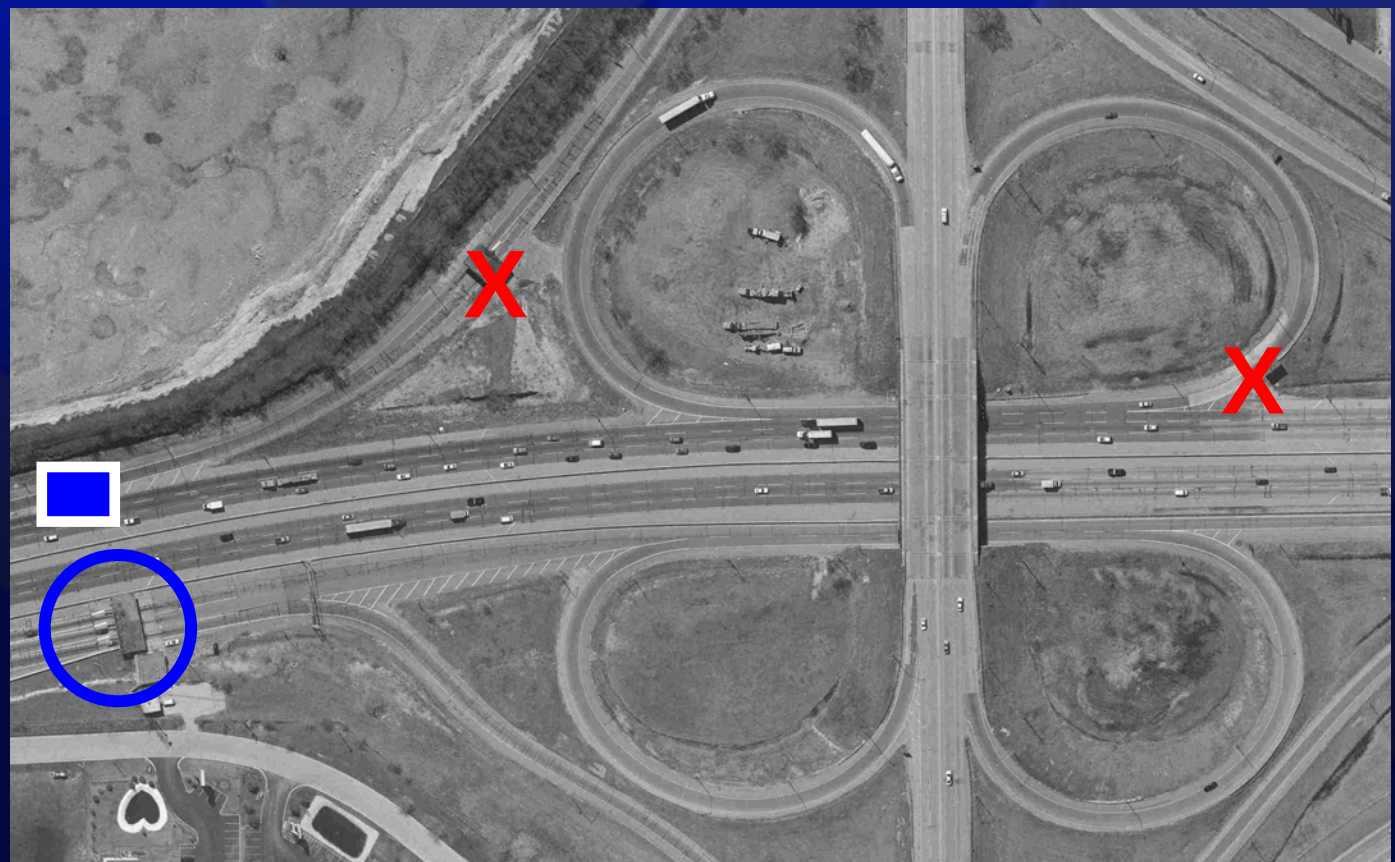
Special Design and Environment - Toll Collection

- 3 plazas became 2 plazas (eliminated construction and future maintenance costs)
- Improved operations by eliminating a stop point



Special Design and Environment

- Environment (CSS)
  - Council of Indian tribe coordination
  - Foundation design to permit groundwater flow
  - Animal passage
  - Limit forest preserve ROW and impacts to threatened orchid
  - Coordinated and considered a bicycle path and park
  - Aesthetic treatment of walls
- Performance Specifications
  - Some design moved to contractor
  - Expedited project delivery
  - Favorable material pricing

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Summary

- Consider design element interrelationships
- Develop knowledge of new design publications
- Communicate with client
- Utilize innovative design techniques
- Performance specifications to expedite design process and provide material flexibility
- Successful bid of $136 million
- Applicable to other projects

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