Advance Features in NEMA Controllers for Oversaturated Conditions

TRB Signal Systems Committee
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Oversaturated Conditions

• **Type**
  - *Expected*
  - *Unexpected*

• **Duration**
  - *Long term*
  - *Short term*
  - *Cyclic*
Controller Features

• Uncoordinated
  – Dynamic maximum

• Coordinated
  – Force off
    • Floating
    • Fixed
  – Dynamic split
Evaluation

- Used Hardware-in-the-loop simulation
  - *Real world scenarios*
  - *TSIS 5.1*
- NEMA TS-2 Controllers
  - *Eagle*
  - *Naztec*
- Research conducted for TxDOT projects
Dynamic Maximum

- Under actuated control
- Increases the maximum in steps when the phase is repeatedly maxing out
- Reduces the maximum when gapping out
- Applicable for one or more intersection phases
Transportation Operations Group

Dynamic Maximum

0 5 10 15 20 25 30 35 40 45 50

1 2 3 4 5 6 7 8 9 10 11 12 13

Cycle Number

Green Time and Max Time (seconds)

Dynamic Max Limit

Dynamic Max Step

Normal Max

Maxed out twice

Gapped out twice

Maxed out twice

Actual Green Time

Running Max Time

Transportation Operations Group
Simulation
Applicability

- Unexpected diversions
  - *Frontage roads*
- Need to consider the impacts of a longer cycle length on other approaches
- Responds 2 cycles after oversaturation on the approach
Force Off Modes

- Excess capacity from one phase available for another phase
- Two options
  - Floating
  - Fixed
- Off peak and peak timing
- Varying demand on the cross-street
Floating Force Off

- Phase 2 & 6
- Phase 3 & 7
- Phase 4 & 8
- Phase 1 & 5
- Early Return to Phase 2 and 6

Excess Capacity
Excess Demand

Programmed Splits
Cycle Demand
Actual Splits
Early Return to Phase 2
Average Intersection Delay

Delay (seconds/vehicle)

Floating     Fixed

Force Off Mode
Average Approach Delay

- Eastbound: 22.3, 24.4
- Westbound: 13.9, 15.6
- Northbound: 46.1, 47.4
- Southbound: 290.2, 79.9

Delay (seconds/vehicle)

- Eastbound: Floating 22.3, Fixed 24.4
- Westbound: Floating 13.9, Fixed 15.6
- Northbound: Floating 46.1, Fixed 47.4
- Southbound: Floating 290.2, Fixed 79.9

Transportation Operations Group
Applicable

- Used Fixed force off where the phase(s) later in the sequence tend to force off more often (critical)
- Fixed force off also minimizes early return to the coordinated phases
- Have to consider the impacts of either mode on adjacent intersections
Dynamic Split

- Coordinated control
- Takes time from one non-coordinated phase which is gapping out to another non-coordinated phase which is maxing out
- Typically works in 1 second increments
Transportation Operations Group

Phase 2 (Coordinated)

Phase 1

Phase 4 (with excess demand)

Original split (40 seconds)

Final dynamically adjusted split (50 seconds)
Availability

- **Eagle**
  - Non-diamond mode
  - Diamond mode
  - Coordination Adaptive Split (CAS)

- **Naztec**
  - Non-diamond mode
  - Critical Intersection Control (CIC)

- **Other controllers**
Summary

• Utilize available features in controllers to handle unexpected surges in traffic
• However evaluate the impacts of using these features on other approaches or adjacent intersections
• Know your controller – S. Click