

VMS AND HAR MESSAGE PROJECT

IMPROVING THE HIRING, RETENTION, AND DEVELOPMENT OF NEW JERSEY DEPARTMENT OF TRANSPORTATION TRAFFIC OPERATIONS CENTER STAFF

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And

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1. INTRODUCTION

STATEMENT OF THE PROBLEM

New Jersey Department of Transportation (NJDOT) Traffic Operations Centers (TOCs) serve a vital role in maximizing mobility of travelers throughout New Jersey and the entire Northeast Corridor. Decisions made and actions taken by TOC operators directly influence the operational efficiency of the roadway system in the region, and affect the overall levels of public opinion of NJDOT. Having a competent, qualified, and motivated TOC workforce is therefore essential if these centers are to continue to be successful in the future.

Similar to agencies operating TOCs in other parts of the country, though, the NJDOT has experienced some difficulties in continuing to meet the staffing needs of its centers. The functions and tasks typically performed in a TOC require staff with knowledge, skills, and abilities outside the range of existing employee title structures, position descriptions, and salary levels available within the department. At the same time, the continuous (or nearly so) operation of a TOC means that staff are typically faced with non-standard and sometimes varying shift schedules, periods of intense work activity during major incident conditions and such, as well as periods of fairly light work that can potentially result in periods of operator boredom.

Because of these unique challenges, NJDOT contracted with the Texas Transportation Institute (TTI) to assess and recommend ways that the agency could improve hiring and maintaining adequate levels of staffing with the required knowledge, skills, and abilities in its TOCs.

CONTENTS OF THIS REPORT

In the next chapter, researchers describe the results of a telephone survey of TOC managers and supervisors in several states nationwide. These interviews were designed to gather input as to current issues in hiring and retaining quality staff in TOCs, and steps agencies have taken to address those issues. The interviews were also structured to gather data regarding TOC operator pay scales and how it compares to other job titles with similar salaries, methods of evaluating operator performance, necessary qualifications and skills (and methods of assessing those skills). Researchers also inquired about training requirements and opportunities provided at those TOCs to encourage regular and continuous improvement.

In Chapter 3, researchers summarize the desirable knowledge, skills, and abilities (KSAs) for NJDOT TOC operators. The KSAs were extracted from the previously-published Federal Highway Administration (FHWA) document *Guidelines for TMC Transportation Management Operations Technicians Staff Development*.⁽¹⁾ Researchers tailored these KSAs to the specific functions and operator tasks that the

NJDOT and the Project Advisory Committee identified as essential for TOC operators (both entry-level and fully-trained operators). These KSAs are compared against the existing NJDOT position descriptions for Engineering Technicians 1 through 5, the positions from which operator personnel are currently obtained.

In Chapter 4, researchers provide a discussion and recommendations regarding training opportunities that are likely to help operators advance in their careers and become more effective at their jobs within the TOC. These recommendations are again based on the FHWA *Guidelines*. Training opportunities available via the National Highway Institute (NHI), Center for ITS Training and Education (CITE), and New Jersey Department of Personnel (NJDOP) programs are also identified.

The final chapter of the report contains a series of recommendations that the authors believe will improve the hiring, retention, and development of NJDOT TOC staff in the future.

2. SURVEY OF TRAFFIC OPERATION CENTERS NATIONWIDE

Researchers conducted a series of telephone interviews to gather input as to current issues in hiring and retaining quality staff in TOCs, and steps agencies have taken to address those issues. The interviews were also structured to gather data regarding TOC operator pay scales and how it compares to other job titles with similar salaries, methods of evaluating operator performance, necessary qualifications and skills (and methods of assessing those skills), and training requirements/opportunities provided to encourage regular and continuous improvement. Specific questions that served as the basis for the interviews are provided in appendix A.

CENTERS CONTACTED

The authors contacted managers and/or supervisors at TOCs in the following states:

- California,
- Connecticut,
- Georgia,
- Illinois,
- Maryland,
- Michigan,
- Minnesota,
- New York,
- Pennsylvania,
- Texas,
- Toronto,
- Virginia,
- Washington, and
- Wisconsin.

The authors also reviewed published operations documents and summaries of several of these systems. ^(See references 2 through 8) The TOCs in these states vary widely in physical and staffing sizes, times of operations, and amount of equipment and mileage that the staff is responsible for (see tables 1 and 2). In most cases, information gathered by the authors pertained to a specific operating center. In a few instances (e.g., California), the information provided by the agency contact represented multiple TOCs in that state. As is illustrated in the tables, significant differences exist in staffing levels across the centers. Specifically, the authors found that TOCs staffed their centers (in total) at a rate of one TOC operator staff per 12 to 105 miles of centerline miles of surveillance responsibility per 40 hours of operation per week, and one operator on staff per 3.0 to 45.0 variable message signs (VMSs) of responsibility per 40 hours of TOC operation per week. Those centers that have higher VMS-to-staff ratios generally have a higher degree of message display automation (i.e., automatic travel time displays, scenario-

based message selection and display algorithms, etc.). Using a weighted average of these data, the researchers recommend that NJDOT TOCs strive to maintain staffing levels at one operator for every 26 centerline miles of roadway responsibility in the TOC per 40 hours of operation per week, or one operator for every 15 variable message signs of responsibility per 40 hours of TOC operation per week.

Table 1. Overview of TOC Characteristics.

| | Center Size | Times of Center Operations | Shift Times and Staffing |
|---------------------------|--|---|--|
| California (8 TOCs) | 230 – 60,000 ft ² | Most 24/7/265, some 24/5 | Varies by TOC |
| Connecticut (2 centers) | 2,500 ft ² control rooms (approx) | 24/5, some weekends | 9-hr shifts, 1-hr overlaps; 2 persons per shift |
| Georgia (Atlanta) | 73,498 ft ² building | 24/7/365 | 8.5-hr shifts, 30-min overlaps; 6 persons per shift |
| Illinois (Chicago) | --- | 24/7/365 | --- |
| Maryland (Baltimore) | 20,000 ft ² building | 24/7/365 | 10-hr shifts, 2-hr overlaps; 5-6 persons per shift |
| Michigan (Detroit) | 2,400 ft ² control room | 5 days a week (assumed) | 2 shifts per day, 3 people per shift |
| Minnesota (Minneapolis) | 18,000 ft ² building | 5:30 am-8:30 pm weekdays, 8 hrs weekends | All shifts are part-time; 4 persons per shift |
| New York (INFORM) | 2,925 ft ² control room | 24/7/365 | 8-hr shifts, no overlap; 6 persons per shift |
| Pennsylvania (District 6) | 5,000 ft ² control room | 4:30 am-8:30 pm weekdays, some weekends | 4:30 am-1 pm, noon-8:30 pm; 2-3 persons per shift |
| Texas (Houston) | 54,000 ft ² building | 24/7/365 | 9-hr shifts, 1-hr overlap; 3-4 persons per shift |
| Texas (San Antonio) | 53,000 ft ² building | 24/7/365 | 9-hr shifts, 1-hr overlap |
| Toronto | 1,500 ft ² control room | 24/7/365 | 8-hr shifts (no overlap) weekdays, 12-hr shifts occasionally on weekends |
| Washington (Seattle) | 6,000 ft ² control room | 6 am – 7pm weekdays, some weekends | 1 full-time supervisor present, students man 4-hr shifts during peak periods |
| Wisconsin (Milwaukee) | 10,000 ft ² leased space | 4 am–9 am & 3 pm–9 pm weekdays, some weekends | 1 full-time supervisor covers each period, 1 part-time student operator covers 2 hr peak periods |

--- data not available

Table 2. TOC Surveillance and VMS Responsibility.

| | Total Number of Operators on Staff | Centerline Miles under Surveillance | Surveillance Miles per TOC Staff per 40 Hours of Operation | Number Of VMS | VMSs per TOC Staff per 40 Hours of Operation |
|---------------------------|---|--|---|----------------------|---|
| California (8 TMCs) | 2-25 per TOC | Varies by TOC | --- | 5-136 per TOC | --- |
| Connecticut (2 centers) | 14 per TOC | 150 combined | 16.1 | 23-50 per TOC | 4.9 – 10.7 |
| Georgia (Atlanta) | 30 | 88 | 12.3 | 65 | 9.1 |
| Illinois (Chicago) | 6 | 150 | 105.0 | 22 | 15.4 |
| Maryland (Baltimore) | 30 | 49 | 6.9 | 64 | 9.0 |
| Michigan (Detroit) | 16 | 180 | 22.5 | 64 | 8.0 |
| Minnesota (Minneapolis) | 29 | 230 | 18.0 | 69 | 5.4 |
| New York (INFORM) | 19 | 220 | 48.6 | 174 | 38.5 |
| Pennsylvania (District 6) | 9 | 70 | 15.6 | 41 | 9.1 |
| Texas (Houston) | 12 | 160 | 56.0 | 100+ | 35.0 |
| Texas (San Antonio) | 14 | 94 | 28.2 | 90 mainlane, 60 ramp | 45.0 |
| Toronto | 13-18 | 210 | 49.0-67.8 | 40 mainlane, 30 PCMS | 16.3– 22.6 |
| Washington (Seattle) | 14 | 130 | 15.1 | 70 | 8.1 |
| Wisconsin (Milwaukee) | 13 | 124 | 13.1 | 28 | 3.0 |

VMS = variable message sign

The authors did review operator schedules as part of the interview process. Overall, 8- to 10-hour shifts were the most common schedules for those TOCs operating continuously on a 24/7 basis. The TOC supervisors typically overlap start and end times of operator shifts by 30 minutes to an hour each day as a means of operators to hand off the management of any incidents that may be underway. A few supervisors did indicate that their operators may occasionally work a 12-hour shift, but only for unusual instances such as a special event. In addition, these types of occasional shifts were more likely to occur at TOCs that were not operating continuously (i.e., an

operator may be called in to work a Saturday or Sunday for an event, even though the TOC is normally not staff on the weekends).

FINDINGS

Operator Recruitment and Pay

Key Issues

The authors queried the TOC supervisors and managers as to the key issues encountered with respect to hiring and keeping qualified operators. The key issues are listed in figure 1. Interaction with, and requirements of, the human resource department or division regarding the hiring process was mentioned a few times as somewhat of an issue, but not one that supervisors and managers as a group could not overcome.

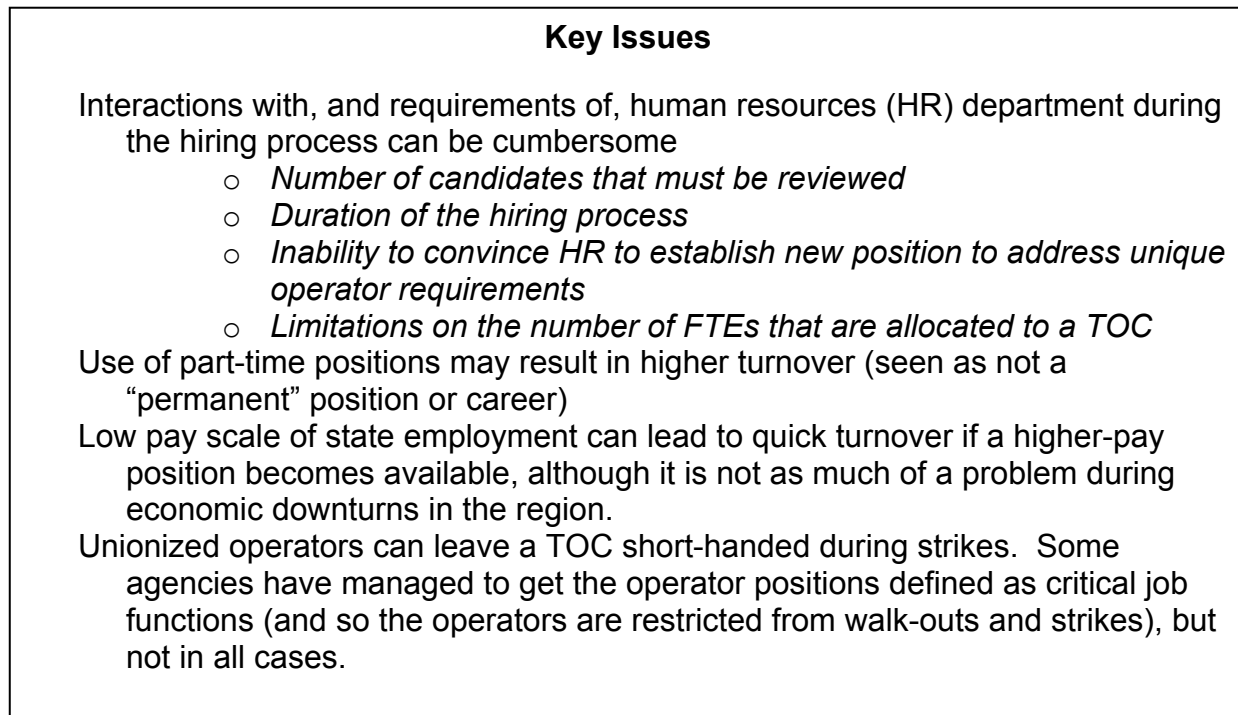


Figure 1. Key Issues in Operator Recruitment and Retention.

Another key issue acknowledged in the interviews was the continuing pressure to downsize state agencies, such that full time equivalent staff members (FTEs) needed to operate a TOC are sometimes not allowed to be filled in order to meet a staffing shortage elsewhere. Several of the centers reported establishing relationships with local universities to hire college students (generally those in a technical field) to work part-time in the centers as a way of alleviating staffing shortfalls. Supervisors and managers in these centers noted the use of students to man the operations center also worked well to address the peak periods that occur each day (instead of attempting to

hire staff who are willing to work part time or to work split shifts). Student workers are typically not compensated with the same benefits as full-time staff and generally do not come under the purview of the human resources (HR) department, giving supervisors and managers much more flexibility and timeliness in making hiring and staffing decisions. For some agencies, they simply advertise for student help through their own intern program. Other agencies have established explicit relationships with the university to recruit and hire the necessary student help. In one instance, the relationship was established in order to allow student help to be paid from other than the TOC operating funds (research funds were allocated for this purpose).

Three of the agencies relied on consultants to operate their TOCs. In each case, agency personnel provided overall supervision of the operations. In general, all three agencies felt that this arrangement worked well, and reduced the bureaucratic difficulties associated with hiring and retaining operators within the agency. However, the supervisors and managers did acknowledge that this arrangement did complicate the day-to-day operation of the TOC slightly, adding another layer into the organizational structure.

A low pay scale was identified as an issue mentioned by three agencies. The remaining agencies did not indicate that the pay scale contributed adversely to the hiring or retention of employees. The typical pay range for several of the TOCs surveyed is provided in figure 2. Furthermore, it is interesting to note that those agencies who reported pay scale difficulties in hiring new operators are those which fall under the estimated appropriate pay range for operator personnel in the recent *Guidelines*.⁽¹⁾ Several of the supervisors interviewed in this study did mention that the goal of many of the operators is to become employed with the state so as to obtain health and other benefits that are becoming more and more difficult to come by in the private sector.

A final issue mentioned by a few of the center supervisors and managers was the difficulties encountered with the use of union personnel as operators in a TOC. Whereas union requirements concerning salary, benefits, and working conditions were not felt to be detrimental to the overall function of the center, labor disputes that have resulted in operator staff walking off their jobs have created significant difficulties for agency management staff to maintain full operation of the TOC. One agency was able to get the operator staff position classified as a critical function (and thus the operators were prohibited from walkouts during labor disputes), but other agencies have not been as successful. This is another reason why one agency has moved towards including student workers in their overall TOC staffing plan.

Examples of TOC Operator Pay Scales

| | |
|--------------------------------------|--|
| Georgia ^a : | \$20,000+ annually (entry-level) |
| Texas (Houston) ^a : | \$20,800 - \$23,000 annually (entry-level) |
| Pennsylvania ^a : | \$20,900 - \$30,000 annually (entry-level) |
| Maryland: | \$26,500 - \$41,800 annually (entry-level to advanced) |
| Washington (Seattle) ^b : | \$27,000 - \$31,300 annually |
| Texas (San Antonio): | \$28,800 annually (entry-level) |
| California: | \$29,000 - \$50,900 (entry-level to advanced) |
| Wisconsin (Milwaukee) ^b : | \$31,300 - 37,600 annually |
| Toronto ^b : | \$37,000 - \$43,000 annually |
| Connecticut: | \$37,600 - \$45,900 annually (entry-level to advanced) |

Estimate of comparable salary based on analysis of federal job classifications: ⁽¹⁾

\$24,700 - \$37,400 annually
\$27,100 - \$33,500 annually in high cost-of-living locations

^a Low pay scale cited as a hindrance to hiring

^b Supervisory operator roles; student workers used for entry-level to full-performance operator tasks

Figure 2. Example of Operator Pay Scales in Use.

Titles Used

The authors found a wide variety of titles or classifications used for TOC operator staff. Some of these included:

- Dispatcher or Dispatch Clerk (some centers rely on their dispatchers to operate VMS and other features during low-volume periods),
- Highway Operations Technician,
- Operator,
- ITS Technician,
- System Support Specialist,
- Traffic Management System Operator,
- Transportation Engineer Technician,
- Transportation Management Center Console Operator, or
- Traveler Information Operator.

Some of the supervisors and managers were able to identify other types of job titles elsewhere in the agency where the pay scale were similar to these operator positions. These titles included general engineering technicians, maintenance technicians, signal technicians, design technicians, and ITS designers.

Source of Operators

Most of the agencies that staff their own TOCs reported that they recruited new operators (non-student positions) from outside of the organization, through the standard job description posting and interview process (a fairly cumbersome and time-consuming process as noted above). Those few agencies that did obtain operator staff from within their own organizations tended to be the ones with higher typical salaries for operators (i.e., Connecticut, Toronto).

Most agencies indicated that operator position job vacancy notices were posted on their Department of Transportation (DOT) website (as are other types of vacancy notices for the agency). The human resource department of a few agencies periodically posts a notice of a vacancy in the newspaper as well. None of the agencies interviewed indicated that they were willing or able to offer any other extra enticements to increase interest in the position. In fact, as noted previously, the agencies generally had more applicants for each position than they would prefer to review (one supervisor noted that he typically had to review and rate 25 applications for each operator position that was posted).

Operator Turnover

The supervisors and managers as a group acknowledged that shift work did tend to make it more difficult to fill and retain operator positions, and sometimes a new hire does quit after only a short time (which requires them to re-initiate the recruitment process). Generally speaking, however, this type of behavior was the exception rather than the rule with most supervisors and managers. One agency reported a 25 percent turnover in operators annually. Elsewhere, the turnover rate was much lower, estimated to be on the order of 10 percent or less annually.

Several of the managers believed that it is possible to avoid these types of problems through proper screening and interviewing during the hiring process. Emphasizing the fact that the position did involve rotating shift work was one way that supervisors helped to screen candidates. A few supervisors noted that slightly older employees who have previous military experience had also been found to be especially well-suited as operators. Supervisors and managers hypothesize that these individuals are already comfortable with the command and control nature of TOC operations. Furthermore, many of these individuals had already retired from the military with some type of pension and so were less concerned with the amount of pay that could be obtained in that type of position.

One agency supervisor noted that they were able to retain the operations staff more easily through a well-defined career advancement program that they had established. This career path is based on a combination of experience, training, and testing requirements established for each advancement level. Employees do not compete for higher-level positions within the TOC, but rather advance automatically as they accomplish the various requirements for the next level or position. The supervisor felt that this not only helped retain staff, but kept employee morale at a high level as well. The difficulty with the approach is with ensuring that the dollars necessary for the advancements are ensured through appropriate policies and procedures within the agency.

TOC Staff Qualifications and Skill Requirements

Operators

The authors queried the TOC managers and supervisors as to the educational requirements and other qualifications they required of new applicants for operator positions, and those they used to determine when operators were ready to be promoted to higher levels of responsibilities such as lead operator or shift supervisor. Essentially all centers required new operator hires to have a high-school diploma or equivalent as the base educational requirement. Some centers gave increased consideration to additional engineering technology education, but not all. One TOC pursues operators who have a bachelor's degree, but has trouble retaining such employees because they can command a higher salary in the private sector than what the agency offers for the operator position. A common comment by several of the managers and supervisors interviewed was that the educational requirements for the position were not as important to them as specific skills and abilities that an applicant needs to be effective as an operator in the TOC.

The authors found considerable variability in how specific the TOCs were in their skill requirements for their operators. Generally, larger TOCs with more staff tended to have more formalized procedures and requirements in place. Overall, the authors found that essentially all requirements mentioned in the interviews could be located in the FHWA *Guidelines*.⁽¹⁾ This document, developed through an FHWA/state DOT pooled-fund study, addresses operator qualifications through a comprehensive consideration of the key functions that are accomplished in a particular TOC and the various tasks that operators are required to perform as part of those functions.⁽⁹⁾ Although a large number of specific TOC functions were identified in the *Guidelines*, they have been grouped around the following key items:

- Provide travel information,
- Records management,
- Congestion management,
- Failure management,
- Incident management,

- Special event management,
- Traffic flow monitoring,
- Emergency management,
- Provide/coordinate service patrols,
- Reversible and HOV lane management,
- Traffic signal system management,
- Transit vehicle monitoring,
- APTS system management,
- Environmental and RWIS monitoring,
- Overheight vehicle management, and
- Rail crossing management.

From this list of key TOC functions, the *Guidelines* contain a list a total of over 1000 specific operator tasks that could be required. However, many of these tasks are either interrelated or are typically combined with other tasks (that is, they become composite tasks), or are highly specific and applicable to only a limited number of TOCs nationwide. In general, the skill and knowledge requirements are grouped around the following list of key operator performance requirements:

- Utilize a graphical user interface (GUI) at a mouse, keyboard, and video (MKV) terminal;
- Utilize multi-channel telephone and radio headset;
- Obtain visual information from display wall;
- Read, understand, and act in accordance with agency policies and procedures;
- Read, understand and perform procedures in System Operator Manual;
- Verbally communicate to coordinate activities with other TOC operators and supervisors;
- View traffic data;
- View video images;
- View weather data;
- View emissions data;
- Detect events (video images, audible sources such as radio monitoring, telephone notification);
- Verify and extract key information from video images (crash severity, agencies to contact, etc.);
- Coordinate with interagency traffic management personnel during confirmed incidents;
- Activate ramp meters or lane use signals in response to incident;
- Adjust traffic signal timings in response to incident;
- Activate variable message signs (VMS) in response to incident, or to support reversible or HOV operation;
- Observe traffic data and video images and update response plan as lane configurations and incident site conditions change;
- Acknowledge detected failures, diagnose failures, implement repairs, dispatch/notify traffic signal repair technician(s);
- Utilize VMS in a system;

- Record HAR or 511 messages;
- Utilize ATIS;
- Utilize APTS, notify travelers of transit locations and headways;
- Meter ramps (including adjustment of metering rates);
- Respond to public inquiries (i.e., phone calls for travel assistance from travelers);
- Respond to media inquiries (interviews during traffic events, broadcast television requests for live broadcasts from TOC or incident site);
- Update website with ATIS information;
- Acknowledge TOC software failures, look up error codes and diagnose failures, warm and cold restarts of systems, dispatch/notify computer hardware technician(s) when appropriate; and
- Life-safety event handling, regulatory device operation to prevent accidental loss of life

For each of these performance requirements, statements are provided in the *Guidelines* of (1) the necessary knowledge that an operator must possess related to that task (i.e., knowledge that would allow the operator to answer questions pertaining to the task), (2) the skills needed to actually perform that task, and (3) the abilities or physical capacities that the operator must possess in order to demonstrate a particular skill. These key performance requirements can be further dissected and/or recombined as needed by a particular TOC to tailor a description to meet the specific details of a position.

These definitions are not always easy to differentiate between, but do allow for flexibility when defining human resource requirements for job postings, and for determining when a person has reached an acceptable level of mastery over that task. For example, a position description might have as a knowledge requirement the understanding of standard computer operations in a Windows-type environment, or the ability to properly operate a channelized two-way radio headset with selectable frequencies. Such knowledge could be verified through simple questions pertaining to the operation of these devices. Similarly, these same two devices could have skill requirements identified for them, such as being able to type data entry into a computer terminal at a minimum of 50 words per minute at 97 percent accuracy, or switching between multiple calls into the center quickly and without losing any callers in the process. Such a skill set could be defined and tested objectively to verify the level of proficiency that is desired. Finally, the abilities identified for each task are those statements that would comprise a typical position posting for a job in order for the candidate to determine if he or she has the type of background and necessary experience to demonstrate an adequate level of knowledge and/or acceptable skills for the position.

Obviously, not all of these requirements pertain to an entry-level operator in all centers. A distinction is made in the *Guidelines* between entry-level operators, full-performance operators, and advanced operators. Entry-level operators will tend to be hired on the basis of the specified abilities and knowledge levels for those performance requirements deemed most appropriate to the center. Necessary skill sets will most often be used to determine when an operator has reached a level of mastery of a particular performance requirement. Once a set number of performance requirements have been mastered, the individual will be considered as a full-performance operator. The advanced operator

would be someone who is eventually considered by the center supervisor or manager as an “expert” in the various functions and performance requirements of the center. This type of person would be capable of operating at a much higher level of independence to meet the center functions. Advanced operators would also be expected to master the automated systems used at the TOC, and have knowledge of remedial measures required to correct or work around system failures. ⁽¹⁾

TOC Supervisors

In addition to fully grasping the technical aspects of TOC operations and reaching what would likely be termed the “advanced” operator level as discussed above, TOC supervisors generally require additional training and experience related to the administrative aspects of TOC operations. Several managers and supervisors interviewed noted that they were required to complete internal courses on employee conflict resolution, personnel management, motivation, etc.

TOC Engineers

Supervisors and managers indicated that not all TOCs incorporated an engineer into their staffing plan. Rather, some of the smaller centers did have engineering oversight, but the engineer had other duties in addition to the TOC. Larger centers did tend to have specific engineering staff on hand (the actual numbers varied based on size of the center and level of maturity of the surveillance system deployed in the region). The engineers tend to be trained as civil engineers, although some TOCs also employed one or more electrical engineers on staff. Training and capabilities in intelligent transportation systems (ITS) was also cited as a key requirement by many of the supervisors and managers, consistent with recent FHWA recommendations. ⁽¹⁰⁾

TOC Staff Training

TOC supervisors and managers all indicated that they had some type of training program established for new operator hires. Some of the TOCs also had training activities identified to further operator capabilities and functionality over time. The authors found that the majority of training activities were primarily introductions to the various devices and controls being managed in the TOC (i.e., how to log into the system, how to select and move cameras, how to type in and put up messages on the VMS, etc.). In several instances, vendors of the technology being operated in the TOC were brought in as needed to provide the training, which could vary in duration from a few hours up to 40 hours. In other instances, the supervisor or an experienced operator provided instructions to the new hire on how to operate the equipment through informal on-the-job training (OJT).

Both the California Department of Transportation (Caltrans) and the Maryland State Highway Administration are agencies that have established formalized training programs for their TOC operations staff. The Caltrans program is highly organized, and

is addressed through a 36-hour basic training course conducted at the Transportation Management Center Academy at the Transportation Management Center simulation facility on the Cal Poly San Luis Obispo campus. Among the topics addressed during this five-day course are the following:

- Partnerships and team building (3.5 hrs);
- Conflict resolution and role playing (2 hrs);
- Customer service and performance measures (2 hrs);
- Incident command systems/standardized emergency management system and media relations (3 hrs);
- Traffic management teams – best practices (1 hr);
- Variable message signs and highway advisory radio (2 hrs);
- Traffic operations terminology (1 hr);
- TOC best practices and regional differences (1 hr);
- Computer-aid-dispatch instruction, protocol, radio codes (4 hrs);
- Case studies (1.5 hrs);
- Simulator activities of various hypothetical scenarios (12 hrs, 6 of which are actual “hands-on” practice); and
- Final review, exam, closing remarks, course evaluation (3 hrs).

The *Guidelines* present a recommended training program that is similar in content to the Caltrans program, but without access to a TOC simulator. ⁽¹⁾ The amount of training recommended (particularly for advanced operator status) can be quite lengthy in some areas. Topics recommended for inclusion in an operator training program are the following:

- Orientation to the TOC (2-4 hrs);
- Nuts and bolts of the control room (2-4 hrs);
- Knowledge of the transportation system (16 hrs OJT during first week);
- Knowledge of the transportation operations system and devices (16 hrs OJT during first two weeks, 24 hrs OJT over the following six months);
- Public and media interactions (4 hrs);
- Software/equipment, including:
 - Basic application software/operating system, wall maps, and GUI features (2-4 hours depending on learning skills);
 - Ramp meters and traffic signals: 4-6 hours depending on learning skills;
 - Variable message signs (2-4 hours depending on learning skills);
 - Video surveillance, two-way radio, loop detectors, automated weather stations, traffic sensors (2-4 hours depending on learning skills);
 - Web site management -- technical capabilities and limitations of using the web site to provide information to the public (1-2 hours depending on learning skills);
- Principles and practices of technical traffic engineering (8 hrs sometime after 6 to 18 months of employment);
- Options for advanced training (depending on functions of TOC), including:
 - Traffic Planning (20-30 hrs);
 - HAZMAT (20-30 hrs);

- Ramp metering, traffic signal control timing selection plans, and traffic controls at railway intersections (20-30 hrs);
- Creative problem solving (20-30 hrs);
- Trouble shooting software/equipment problems (20-30 hrs);
- Team building and conflict resolution (20-30 hrs); and
- Overheight vehicles (8 hrs).

TOC Staff Performance Evaluation

For the most part, operator staff evaluations are handled through the standard employee performance evaluation process in place within each agency. Supervisors and managers meet with operators yearly to identify both strength areas and opportunities for improvement. A few supervisors used a few objective measures (such as the number of absences the employee had during the year, or the number of improper VMS messages displayed that the supervisor had noticed through reviews of a sample of previous postings, etc.). Other supervisors and managers relied on more open-ended assessments of employee performance. None of the supervisors contacted indicated difficulties or dissatisfaction with the overall evaluation process. However, some supervisors did note that a lack of sufficient operating funds did sometimes limit them from adequately rewarding high-performing employees.

SUMMARY

The interviews illustrated that TOC staffing can be accommodated in a variety of ways, each with its own set of advantages and disadvantages. The advantages and disadvantages associated with utilizing full-time agency staff, consultants, or students as operators in a TOC are summarized in table 3. Generally speaking, agencies that opt for either contractors or students to help fill TOC operator roles relinquish some degree of management control over their operations, and must plan to replace operator staff on a regular basis (in cases where student operators are utilized).

Offering a competitive salary is a key determinant in agency efforts to attract and retain TOC staff. Those agencies that offer entry salaries less than those estimated for comparable job duties in the recent *Guidelines* have found it difficult to attract and keep good staff.⁽¹⁾ The *Guidelines* indicate that the comparable pay scale nationally for entry-level TOC operators is approximately \$24,700 annually, and \$27,100 for high cost-of-living areas. Furthermore, agencies that have mechanisms for rewarding those employees who demonstrate increasingly advanced skills and knowledge relative to TOC operators (i.e., certification levels that are tied to automatic salary increases and promotions) appear to have better luck at retaining high-quality employees than those who rely on competitive merit-based promotions for staff advancement.

Table 3. Summary of TOC Staffing Options.

| Staffing Option | Advantages | Disadvantages |
|--|---|--|
| Hiring agency employees to staff all positions | <ul style="list-style-type: none"> ■ DOT maintains primary control over all TOC staff activities, performance, and salaries | <ul style="list-style-type: none"> ■ Hiring process time-consuming ■ Ability to retain new hires dependent upon offering competitive salary ■ Difficult to adequately staff peak periods through split shifts or part-time employees |
| Using consultants to supplement agency employees for TOC staff | <ul style="list-style-type: none"> ■ Reduces efforts required to screen and hire new employees for entry-level operator positions ■ Costs of employee benefits are typically not borne directly by agency ■ Can reduce or eliminate concerns of walkouts due to union labor disputes | <ul style="list-style-type: none"> ■ Agency does not have direct influence upon staff that are hired, nor day-to-day behavior of contract employees ■ Level of accountability to the public continues to lie with the operating agency (not the consultant) ■ Agency does not have recourse in reducing staff turnover |
| Using students (college or technical schools) to supplement agency employees for TOC staff | <ul style="list-style-type: none"> ■ Salaries and benefits costs are typically lower than for agency employees ■ Can reduce or eliminate concerns of walkouts due to union labor disputes ■ Allows agency to identify high-quality students who should be recruited for full-time employment once student has graduated. | <ul style="list-style-type: none"> ■ Use of students to help operate TOCs involves regular staff turnover due to graduation ■ May require special contracting arrangements with the local university ■ Scheduling may be more complicated to accommodate operator semester changes in class schedules, etc. ■ Union officials may be averse to efforts to employ students for operator tasks |

3. KNOWLEDGE, SKILLS, AND ABILITIES (KSAs) FOR NJDOT TOC OPERATOR POSITIONS

In this chapter, researchers summarize the desirable KSAs for NJDOT TOC operators. The information should also be of value to the partnering New Jersey transportation agencies associated with the VMS and HAR Message Project. The KSAs were extracted from the FHWA *Guidelines*, tailored to the specific functions and operator tasks that the NJDOT and the Project Advisory Committee identified as essential for TOC operators (both entry-level and fully-trained operators).⁽¹⁾ These KSAs are compared against the existing NJDOT position descriptions for Engineering Technicians 1 through 5, the positions from which operator personnel are currently obtained.

CURRENT NJDOT OPERATOR POSITION DESCRIPTIONS

The NJDOP defines five engineering technician position descriptions that are used to hire NJDOT TOC operators. These position descriptions are described in table 4.⁽¹¹⁾ Engineering Technician 5 represents the entry-level position, whereas an Engineering Technician 1 position is the most advanced position available. Engineering Technician 1 and 2 positions involve supervisory activities, while Engineering Technician 3 through 5 positions do not. Other subtle differences in position definitions are also evident in the table (highlighted in italics).

The education and experience requirements for each position as defined by the NJDOP are summarized in table 5. A systematic progression in both education and experience requirements has been established for the five positions. Direct substitution of education via additional experience has also been established (one year experience equates to 30 semester credit hours of education).

The growth in typical job activities amongst the five positions listed in the position descriptions defined by the NJDOP is illustrated in table 6. Again, growth in responsibility and supervisory activities is evident in the progression from Engineering Technician 5 to Engineering Technician 1. As noted under the position definitions in Table 4, a fairly significant increase in the level of supervisory responsibility occurs between the Engineering Technician 3 and Engineering Technician 2 positions.

Overall, the engineering technician position descriptions are defined by generic engineering-type activities. The specific activities that are more unique to TOC operations (particularly the traffic surveillance functions and operations of VMSs that impact the motoring public and the credibility of NJDOT) are not well represented nor explicitly stated in these lists.

Finally, the knowledge and abilities for each engineering technician position as defined by the NJDOP are presented in table 7. As would be expected, substantial similarities exist between the defined knowledge/ability requirements and the examples of work

activities for each position as presented in table 6. However, the knowledge and abilities requirements shown in table 7 do not reflect the unique and specific needs and skills required by personnel who serve as operators in TOCs.

Table 4. Comparison of Current NJDOT Engineering Technician Position Definitions.

| Position | NJPOP Job Specification Number(s) | Definition |
|--------------------------|--|--|
| Engineering Technician 5 | 10116, 59957 | Under <i>close supervision</i> of an engineer or higher level technician in a state department, institution, or agency, performs various semiskilled engineering support functions of a <i>technically routine</i> nature; does other related duties as required. |
| Engineering Technician 4 | 10117 | Under <i>limited supervision</i> of an engineer or higher level technician in a state department, institution, or agency, performs various <i>skilled engineering support functions</i> of a <i>technically complex</i> nature; does other related duties as required. |
| Engineering Technician 3 | 10118, 59956 | Under <i>general supervision</i> of an engineer or higher level technician in a state department, institution, or agency, performs the more <i>technically complex engineering support work and surveys</i> involved in engineering projects; does other related duties as required. |
| Engineering Technician 2 | 10120, 59955 | Under <i>general direction</i> of an engineer or other supervisor in a state department, institution, or agency, <i>supervises a program and/or unit</i> of technicians engaged in engineering support functions; does other related duties as required. |
| Engineering Technician 1 | 10122, 59954 | Under <i>general direction</i> of an engineer or other supervisor in a state department, institution, or agency, <i>supervises two or more units</i> engaged in engineering support functions; does other related duties as required. |

Table 5. Comparison of Current NJDOT Engineering Technician Position Education/Experience Requirements.

| Position | NJPOP Job Specification Number(s) | Education/Experience |
|--------------------------|--|---|
| Engineering Technician 5 | 10116, 59957 | <p>Satisfactory completion of high school level courses in basic mathematics which have included completion of courses in Algebra 1 and 2 levels.</p> <p>One (1) year of engineering support experience performing inspections, investigations, surveys, data collection or completion, drafting, and mathematics computations.</p> |
| Engineering Technician 4 | 10117 | <p>Satisfactory completion of fifteen (15) semester hour credits in an engineering or engineering technology program.</p> <p>Two (2) years of experience performing support tasks involved in planning, surveying, design, inspection, investigation, and/or maintenance of various types of engineering projects or operations.</p> |
| Engineering Technician 3 | 10118, 59956 | <p>Satisfactory completion of thirty (30) semester hour credits in an engineering or engineering technology program.</p> <p>Two (2) years of experience performing support tasks involved in the planning, surveying, design, inspection, investigation, and/or maintenance of various types of engineering projects or operations.</p> |
| Engineering Technician 2 | 10120, 59955 | <p>Satisfactory completion of sixty (60) semester hour credits in an engineering or engineering technology program.</p> <p>Two (2) years of technical experience performing engineering support tasks involved in the planning, surveying, design, inspection, investigation, and/or maintenance of various types of engineering projects or operations.</p> |
| Engineering Technician 1 | 10122, 59954 | <p>Satisfactory completion of ninety (90) semester hour credits in an engineering or engineering technology program.</p> <p>Three (3) years of technical experience performing engineering support tasks involved in the planning, surveying, design, inspection, investigation, and/or maintenance of various types of engineering projects or operations.</p> |

NOTE: Applicants who do not possess the required education may substitute experience as indicated above on a year-for-year basis with one (1) year equal to 30 semester hour credits.

Table 6. Comparison of Current NJDOT Engineering Technician Position Examples of Work Activities.

| Position | NJPOP Job Specification Number(s) | Examples of Activities |
|--------------------------|-----------------------------------|---|
| Engineering Technician 5 | 10116, 59957 | <p>Collects, assembles, analyzes, and records data for engineering and planning projects.</p> <p>Prepares charts, diagrams, graphs, and layouts; reads maps, blueprints, and special plans and drawings; makes simple calculations and computes quantities.</p> <p>Operates and cares for surveying equipment, testing equipment, and/or miscellaneous recording devices.</p> <p>Performs simple chemical and/or physical tests including where appropriate prescribed sampling of liquids or materials; prepares reports summarizing findings and conclusions.</p> <p>Works as a crew member in a small party on surveys, analyses, and/or developments involved in various engineering projects and related work.</p> <p>May assist in preparation of reports and engineering studies.</p> <p>Maintains records and files.</p> <p>Performs snow removal, ice control, and other emergency work.</p> <p>Will be required to learn to utilize various types of electronic and/or manual recording and information systems used by the agency, office, or related units.</p> |
| Engineering Technician 4 | 10117 | <p>All activities listed under the Engineering Technician 5 position, plus the following:</p> <p>Interprets proofs, charts, maps, blueprints, and other plans, and may assist in assembling proposals and other specifications.</p> <p>Acts as leader of a party on surveys involved in engineering projects.</p> <p>Conducts studies, prepares reports, performs statistical calculations, collects samples, and conducts testing.</p> |

| Position | NJPOP Job Specification Number(s) | Examples of Activities |
|--------------------------|--|--|
| Engineering Technician 3 | 10118, 59956 | <p>All activities listed under the Engineering Technician 4 positions, plus the following:</p> <p>Guides engineering technicians engaged in performing engineering support work and surveys involved in engineering and planning projects and related work.</p> <p>Performs the more technically complex duties related to engineering support work and surveys involved in engineering and planning projects and related work.</p> <p>Guides engineering technicians in the collection, assembly, analysis, manipulation, and recording of data for use in engineering projects and/or for use in developing forecasts/projections relative to planning studies.</p> <p>Makes technical evaluations of data and prepares factual reports for use in engineering studies.</p> <p>Reviews charts, plans, maps, and specifications prepared by subordinates for accuracy/ completeness.</p> <p>Participates in the design of features, makes mathematic computations, and checks computations of subordinates for accuracy.</p> <p>Develops and interprets proofs, charts, maps, blue prints, and other plans.</p> <p>Prepares clear, accurate, and detailed reports concerning the engineering support functions of subordinates.</p> |
| Engineering Technician 2 | 10120, 59955 | <p>Organizes, plans, schedules, and supervises activities of a party or parties performing investigations, inspections, and surveys involved in engineering and planning projects and related work.</p> <p>Trains and supervises subordinates in collection, assembly, analysis, manipulation, and recording of data for use in engineering projects and/or for use in developing forecasts/projections relative to planning studies.</p> <p>Visits work locations in the field to ensure that proper procedures are being followed, and to review raw data for accuracy/completeness.</p> <p>Plans, organizes, and assigns work of the organizational unit and evaluates employee performance and conduct, enabling the effective recommendation of the hiring, firing, promoting, and disciplining of subordinates.</p> |

| Position | NJPOP Job Specification Number(s) | Examples of Activities |
|--------------------------|-----------------------------------|--|
| | | <p>Evaluates data at all stages of collection, assembly, and presentation to determine that they meet existing specifications.</p> <p>Develops and interprets the more difficult proofs, charts, maps, blue prints, and other plans, and may supervise subordinates in this work.</p> <p>May maintain complete records pertaining to performance and functions of assigned subordinates.</p> <p>Participates in the design of features; performs mathematic computations involved in engineering construction and operations; may be assigned responsibility for designing small construction projects under direction of an engineer.</p> <p>Establishes sampling plans.</p> <p>Makes studies, prepares reports, performs statistical calculations, collects samples, and makes tests.</p> <p>Ensures that subordinates are familiar with all plans, specifications, policies, procedures, and amendments relating to their specific assignments, and that they are complying with them.</p> <p>Makes recommendations pertaining to specifications, investigations, inspections, and survey procedures.</p> <p>Assumes responsibility for maintenance of records and files.</p> <p>Performs various types of complex surveys necessary for the design and/or construction of state roads, bridges, parks, buildings, and structures including property surveys, horizontal and vertical surveys of projects, and post-construction quantitative analyses.</p> |
| Engineering Technician 1 | 10122, 59954 | <p>All activities (except Establishes Sampling Plans) listed under the Engineering Technician 2 position, and a change to the following:</p> <p>Develops and interprets the more difficult proofs, charts, maps, blue prints, and other plans, and supervises subordinates in this work (note that the word "may" before supervises has been removed).</p> |

Table 7. Comparison of Current NJDOT Engineering Technician Position Knowledge and Abilities Requirements.

| Position | NJPOP Job Specification Number(s) | Examples of Activities |
|--------------------------|-----------------------------------|--|
| Engineering Technician 5 | 10116, 59957 | <p>Knowledge of materials, tools, and equipment used in the particular civil, hydrographic, mechanical, and/or other engineering field concerned.</p> <p>Knowledge of methods used in making mathematic calculations.</p> <p>Knowledge of techniques and procedures used in gathering, analyzing, manipulating, and arranging data for easy reference.</p> <p>Ability to prepare and/or maintain basic maps, charts, graphs, and plans.</p> <p>Ability to work effectively with other employees engaged in survey and related engineering support work.</p> <p>Ability to assist in preparation of factual reports.</p> <p>Ability to maintain records and files.</p> <p>Ability to utilize various types of electronic and/or manual recording and information systems used by the agency, office, or related units.</p> <p>Ability to read, write, speak, understand, and communicate in English sufficiently to perform duties of this position. American Sign Language or Braille may also be considered as acceptable forms of communication.</p> |
| Engineering Technician 4 | 10117 | <p>Knowledge and abilities as defined for Engineering Technician 5, plus the following:</p> <p>Knowledge of procedures applied in engineering activities and related technical operations.</p> <p>Knowledge of materials, tools, and equipment used in various engineering projects.</p> <p>Ability to operate surveying instruments.</p> <p>Ability to read and interpret plans, maps, and specifications.</p> |

| Position | NJPOP Job Specification Number(s) | Examples of Activities |
|--------------------------|-----------------------------------|---|
| | | <p>Ability to maintain effective working relationships with coworkers, supervisor, and with the public</p> <p>Ability to prepare complete, accurate reports.</p> |
| Engineering Technician 3 | 10118, 59956 | <p>Knowledge and abilities as defined for Engineering Technician 4, plus the following:</p> <p>Knowledge of department purposes, procedures, and standards after a period of training.</p> <p>Knowledge of problems that arise when engineering analyses and surveys are made in the field and of the precautions to be taken.</p> <p>Knowledge of techniques and procedures used in gathering, analyzing, manipulating, and arranging data.</p> <p>Ability to organize assigned field and office work, analyze and perform necessary operations, and develop effective work methods.</p> <p>Ability to operate surveying and testing instruments.</p> <p>Ability to prepare clear, technically sound, accurate, and informative reports of investigations, inspections, surveys, and analyses containing findings, conclusions, and recommendations.</p> |
| Engineering Technician 2 | 10120, 59955 | <p>Knowledge and abilities as defined for Engineering Technician 3, plus the following:</p> <p>Knowledge of materials, tools, and equipment used in various engineering, construction, maintenance, and/or operational projects.</p> <p>Knowledge of principles of management and supervision.</p> <p>Ability to organize assigned field and office work, analyze and perform necessary operations, and develop effective work methods.</p> <p>Ability to supervise subordinates and to provide formal/informal instruction.</p> |
| Engineering Technician 1 | 10122, 59954 | <p>Knowledge and abilities as defined for Engineering Technician 2.</p> |

DESIRED KNOWLEDGE, SKILLS, AND ABILITIES FOR NEW JERSEY TOC OPERATORS

A list of desirable TOC functions and operator tasks for NJDOT and its partnering agencies were identified during the Project Advisory Committee meeting held in Trenton, NJ, on December 10, 2003. These functions and tasks were extracted from the FHWA *Guidelines* and were identified as having critical, medium, or low priority or were determined to be not applicable. As a review, the functions considered to be critical to New Jersey TOCs included the following:

- Provide travel information,
- Incident management,
- Special event management, and
- Provide and coordinate service patrols (for NJTA).

The TOC functions prioritized as medium were the following:

- Records management,
- Traffic flow monitoring, and
- Emergency management.

The following functions were considered to have low priority within New Jersey TOCs:

- Congestion management,
- Failure management (TOC system software),
- Provide and coordinate service patrols (for NJDOT TOCs),
- Traffic signal system management, and
- Environmental and roadway weather information system (RWIS) monitoring.

Finally, the following functions were determined to not be applicable to New Jersey TOCs:

- Reversible and HOV lane management,
- Transit vehicle monitoring,
- APTS system management,
- Over-height vehicle management, and
- Rail crossing management.

From these primary TOC functions, a corresponding set of operator tasks were identified, again drawing from a comprehensive list provided in the FHWA *Guidelines*. The following tasks were prioritized as essential (i.e., those an entry-level operator needs to be able to do in a New Jersey TOC):

- Utilize a graphical user interface (GUI) at a mouse, keyboard, and video (MKV) terminal;
- Obtain visual information from video display wall;
- Read, understand, and act in accordance with agency policies and procedures;

- Read, understand and perform procedures documented in a System Operator Manual;
- Verbally communicate to coordinate activities with other TOC operators and supervisors;
- View traffic data;
- View video images;
- Detect events that may impact traffic operations and safety by means of video images, audible sources such as radio monitoring, telephone notification;
- Coordinate with interagency traffic management personnel during confirmed incidents; and
- Respond to public inquiries (i.e., phone calls for travel assistance from travelers).

Next, the following additional tasks were prioritized as desirable and those that a fully-trained operator should be able to do (in addition to those listed above):

- Utilize multi-channel telephone and radio headset;
- View weather data;
- Verify and extract key information from video images (crash severity, agencies to contact, etc.);
- Adjust traffic signal timings in response to incident;
- Activate variable message signs (VMSs) in response to incident;
- Observe traffic data and video images and update response plan as lane configurations and incident site conditions change;
- Acknowledge detected failures, diagnose failures, implement repairs, dispatch/notify traffic signal repair technician(s);
- Utilize VMS in a system;
- Record highway advisory radio (HAR) or 511 messages;
- Utilize Advanced Traveler Information Systems (ATIS);
- Acknowledge TOC software failures, look up error codes and diagnose failures, warm and cold restarts of systems, dispatch/notify computer hardware technician(s) when appropriate; and
- Life-safety event handling, regulatory device operation to prevent accidental loss of life.

For each of these specific operator tasks, the FHWA *Guidelines* presents a set of knowledge, skills, and abilities (KSAs) determined to be necessary for an operator to be able to accomplish that task. Tabular summaries of KSAs by tasks for both entry-level and fully-trained operators are provided in appendix B.

Review of these KSAs in appendix B reveals a number of redundancies amongst the tasks. Furthermore, many of the KSA statements have somewhat different representations than the knowledge and abilities statements that are used in the NJDOP descriptions. Consequently, a consolidated list of knowledge, skills, and abilities for both entry-level and fully-trained operators are presented in figures 3 through 5. A summary of desired education and experience requirements are then presented in figure 6.

DESIRED ENTRY-LEVEL KNOWLEDGE FOR NJDOT TOC OPERATORS

- Knowledge of standard computer workstation operations in Microsoft Windows-type applications environment.
- Knowledge of operation of hold, transfer, speak, listen, speed dial, and other standard business telephone headset features.
- Knowledge of numeric and text data entry and standard editing procedures using a computer keyboard and/or mouse.
- Knowledge of what a computer operating system, a software application, and a data base represents.
- Knowledge on how to use highway maps, video image displays, graphical and text data, and transportation icons to identify physical locations in the covered areas of the system.
- Knowledge of appropriate language and interpersonal communication (listening and speaking) used to conduct commonly used, business-related oral communications.
- Knowledge of local political jurisdictions and institutional relationships.
- Knowledge of key traffic origins and destinations in the covered areas, knowledge of the roadway network and travel conditions by time of day.

ADDITIONAL KNOWLEDGE DESIRED FOR FULLY-TRAINED NJDOT TOC OPERATORS

- Knowledge of operation of channeled two- way radio headset with selectable frequencies.
- Knowledge of impact of adverse weather on transportation systems, including wind, precipitation, temperature extremes, and airborne particulates (smog, fog, smoke, etc.).
- Knowledge of closed-circuit television (CCTV) camera locations and orientation, pan/tilt/zoom camera controls, camera pre-sets, iris functions, and white balance.
- Knowledge of NJDOT public policy principles including customer service, regulation, enforcement, liability, accountability, responsibility, information dissemination, controlled conduct.
- Knowledge of traffic flow characteristics such as speed, velocity, volume, average speed, density, percent occupancy, demand, and capacity.
- Knowledge of roadway geometry and lane configuration, direction, coordinates, links, nodes, zones, sections, mileposts, station numbering.
- Knowledge of general traffic surveillance, control, and data acquisition (SCADA) alarm principles.
- Knowledge of agency radio call signs and protocols.
- Knowledge of traffic law and incident management policies for NJDOT and responders including police agencies.
- Understanding of general traffic signal operations concepts including cycle, split, offset, detectorization and coordination, timing plans, zones, master/slave concepts, saturation, transition cycles, capacity utilization and flow characteristics, and queuing.
- Understanding of what variable speed limits, lane closures, ramp closures, and/or road closures for highways, tunnels, and bridges are meant to accomplish.
- Knowledge of incident response plan generation and traffic management procedures.
- Knowledge of the incident command system used in areas covered by the NJDOT TOCs.

Figure 3. Desired Knowledge Statements for NJDOT TOC Operators.

DESIRED ABILITIES FOR NJDOT TOC OPERATORS

- Ability to comprehend and read English
- Ability to articulate and speak clearly
- Ability to compose full and partial sentences using correct English grammar, spelling, and punctuation
- Proficiency in using the Microsoft Windows Operating System.
- Ability to understand traffic information from visual sources in a transportation schematic.
- Ability to memorize policies related to job duties.
- Ability to read and interpret technical data related to computers and software.
- Ability to follow written instructions with minimal supervision under time pressure.
- Ability to work closely and cooperatively with others in a professional business environment.
- Ability to perform under pressure, including when communications are recorded for third party review.
- Correctly interpret data assembled in a two-dimensional array format
- Ability to scan multiple television monitors and note changes over time to objects and images
- Ability to obtain security clearance and pass a background check (if co-located with police).

Figure 4. Desired Ability Statements for NJDOT TOC Operators.

DESIRED ENTRY-LEVEL SKILLS FOR NJDOT TOC OPERATORS

- Skill to navigate between four or more multiple open application windows in a computer system.
- Skill to enter a minimum of 20 words/numbers per minute with 97 percent accuracy on a computer keyboard.
- Skill to use available computer software macros to accelerate editing of data.
- Skill to execute a single computer control command for a single device (with proper orientation of the operating system).
- Skill to match closed-circuit television camera orientation with static images to determine the orientation of the roadway camera in the field of view.
- Skill to note changed or unusual conditions or appearance of emergency icons on the computer screen within 30 seconds.
- Skill to perform duties consistent with agency policies. Correctly identify situations not conforming to these policies and notify supervisor within 2 minutes.
- Skill to remember or find reference material on policies within 2 minutes.
- Skill to implement error free procedures on the computer system within 2 attempts.
- Skill to communicate effectively, capturing and conveying important information while minimizing superfluous verbiage, slang, and lost data.
- Skill to determine if data viewed on a computer screen is abnormal, anomalous, within or outside a range or threshold.
- Skill to determine if image objects viewed from television monitors are abnormal, anomalous, and reflect any danger to safe and efficient transportation.
- Skill to detect a single event from 6 video-captured still images, in 10 seconds.
- Skill to work two consecutive hours with sufficient focus to respond to audio alarms received in less than 10 seconds, and visual alarms in less than 30 seconds.
- Skill to work two consecutive hours with 100% accuracy taking note of randomly recurring events, at the rate of at least 20 events per hour.
- Skill to memorize all required radio dispatch call signs and policies, and have less than a 3 percent violation rate of protocols.
- Skill to provide effective route information to aid motorist in reaching a destination in a courteous and professional manner.

ADDITIONAL SKILLS DESIRED FOR FULLY-TRAINED NJDOT TOC OPERATORS

- Listen to, and correctly interpret, information from callers, including police dispatchers, other TOC operators, and the public.
- Ability to convey important information succinctly with minimal verbiage.
- Quickly switch between telephone lines without lost calls, use speed and multi-channel dialing.
- Skill in anticipating safety and traffic flow implications of weather fluctuations and events.
- Skill in recognizing weather information values that are out of acceptable ranges.
- Skill in selecting television camera, locating, and zooming in on incident in 360 degree field of view in 30 seconds or less.

Figure 5. Desired Skill Statements for NJDOT TOC Operators.

ENTRY-LEVEL EDUCATION AND EXPERIENCE FOR NEW JERSEY TOC OPERATORS

- Minimum of high school education with 1 year of engineering-related experience and 2 years of on-the-job experience using computers

In addition, one or more of the following is desirable:

- 4 years of experience on 2 roadway systems, advanced map reading level as demonstrated by experience as either emergency medical technician (EMT) driver or US Army private first class (or equivalent), and 20/20 corrected vision.
- 4 years experience on-the-job in position requiring adherence to policy and procedure.
- 2 years participating in goal-directed teams.
- Completion of course material on highway capacity and freeway flow or 2 years experience in a TOC utilizing traffic flow parameters, and demonstrated ability.
- 2 years experience on-the-job with automated alarms in a traffic surveillance, control, and data acquisition work environment, dispatch center, or similar facility, and demonstrated skill level.
- Alternatively, two weeks of advanced traffic management system (ATMS) software training on simulator with two hour focus periods, and/or a four year engineering degree.
- 2 years experience on-the-job with advanced traveler information systems (ATIS) or in TOC or broadcast media work environment, dispatch center, or similar facility, or four year education.

ADDITIONAL EDUCATION AND EXPERIENCE DESIRED FOR FULLY-TRAINED TOC OPERATORS

- 2 years of job experience using a multi-channel business telephone set.
- Successful completion of courses of physical or earth science at 10th-grade level, combined with roadway weather information system (RWIS) vendor training in weather systems.
- Four year college degree in a technical or scientific field with a concentration in traffic engineering, or 10 years experience in traffic control with a government agency or traffic control equipment vendor.
- 2 years experience on-the-job with incident management in an emergency response, police, fire, service patrol, or military work environment, dispatch center, or similar facility. Alternatively, advanced EMT training or 4 year education with major coursework in transportation or emergency preparedness and response.
- Two year technical college degree in electronics, or four year college education in a technical or scientific field covering electronics, or four years of experience in a traffic surveillance, control, and data acquisition-type work environment where monitored points issue failure alarms, or two years prior experience in a TOC having automated failure management.

Figure 6. Minimum and Desired Education and Experience Statements for NJDOT TOC Operators.

The lists of desired KSAs are believed to be sufficient to allow human resource personnel to begin the process of creating new position descriptions for TOC operators, as was discussed at the Project Advisory Committee meeting in December 2003. The list of skills should be particularly useful in establishing appropriate assessment testing tools to identify good operator candidates during the initial applicant screening process. As might be expected, the type and amount of education desired for a TOC operator is more extensive and focused on transportation engineering than is currently specified in the existing Engineering Technician position descriptions. Emphasis on traffic surveillance, control, and data acquisition understanding and experience is also evident.

It should be noted that the list of desired education and experience for entry-level and fully-trained operators will require some resolution by human resource and TOC managers. In particular, the FHWA *Guidelines* indicate that both transportation engineering and a two-year technical degree in electronics would be desirable for a fully-trained operator. However, the latter is desired from the standpoint of having operator staff capable of acknowledging and correcting system failures in either field devices, TOC software, or both. In reality, such expertise may not be truly needed for an operator to be fully functional in the TOC, as other electronics personnel will be available to assist in correcting the defects. From an operator's perspective, the need is not for training that allows for failures to be corrected as much as it is for the operator to simply be able to recognize that some type of failure has occurred (and possibly to help identify the underlying origins and causes). As a result, experience in the TOC may be adequate to allow an operator to recognize and identify system component failures.

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4. NJDOT TOC OPERATOR TRAINING

The review of other state TOC practices indicated that on-the-job training (OJT) constituted the majority of training provided to operators. The list of desirable KSAs previously presented highlight a number of highly-specialized areas of expertise for which more formal training would be desirable. The FHWA *Guidelines* laid out a recommended training program for TOC operators that included both OJT and formalized instruction on various transportation system and traffic flow concepts that would be of benefit to operator effectiveness. The recommended program consisted of the training area shown below. Activities related to the functions and tasks that the Project Advisory Committee indicated were not a part of New Jersey TOCs have been eliminated from this list:

- Orientation to the TOC (2-4 hrs);
- Nuts and bolts of the control room (2-4 hrs);
- Knowledge of the transportation system (16 hrs OJT during first week);
- Knowledge of the transportation operations system and devices (16 hrs OJT during first two weeks, 24 hrs OJT over the following six months);
- Public and media interactions (4 hrs);
- Software/equipment, including:
 - Basic application software/operating system, wall maps, and GUI features (2-4 hours depending on learning skills);
 - Variable message signs (2-4 hours depending on learning skills);
 - Video surveillance, two-way radio, loop detectors, automated weather stations, traffic sensors (2-4 hours depending on learning skills);
 - Web site management --technical capabilities and limitations of using the web site to provide information to the public (1-2 hours depending on learning skills);
- Principles and practices of technical traffic engineering (8 hrs sometime after 6 to 18 months of employment);
- Variable message sign message design and display (10 hours);
 - Options for advanced training, including:
 - HAZMAT (20-30 hrs);
 - Creative problem solving (20-30 hrs);
 - Trouble shooting software/equipment problems (20-30 hrs); and
 - Team building and conflict resolution (20-30 hrs).

The authors reviewed available training resources to identify suitable opportunities to address the other identified training needs (other than OJT). The emphasis was on training that could be offered in New Jersey. A training program on variable message sign message design and display was developed by TTI researchers as part of the VMS and HAR Message Project and is readily available to NJDOT. For other training needs, a number of other potential training sources were consulted, including:

- Institute of Transportation Engineers (ITE).
- Consortium for ITS Training and Education (CITE).

- American Society of Civil Engineers (ASCE),
- Northwestern University,
- Rochester Institute of Technology,
- Rensselaer Polytechnic Institute, and
- NJDOP Human Resource Development Institute (HDRI).

Courses available from the National Highway Institute (NHI) and the Consortium for ITS Training and Education (CITE) appear to have the greatest potential to address training needs pertaining to technical aspects of transportation engineering and management. Meanwhile, the training opportunities provided by the NJDOP appear suitable for addressing the more advanced training needs pertaining to problem solving, team-building, and other supervisory skills. A brief discussion of the courses deemed most appropriate from each of these sources is presented in the following sections.

NATIONAL HIGHWAY INSTITUTE (NHI)

The National Highway Institute (NHI) is a training arm of FHWA. ⁽¹²⁾ Established by Congress in 1970, NHI provides training, resource materials and educational opportunities to the surface transportation community. NHI courses are available to develop core competencies and new skills of the surface transportation workforce and in transferring leading technology and current policies in the U.S. and abroad. NHI courses are designed for the adult learner by incorporating current adult learning principles directly into their curriculum.

NHI follows a standard short course training approach, whereby an agency requests that a course be taught at a given location. NHI hires an instructor to travel to that location and put on the course (anywhere from 1 to 5 days). The sponsoring agency pays a fee for each attendee. This approach works well for traditional state DOT personnel, but is somewhat problematic for TOC operators because of the need to maintain continuous operations while the course is being taught. This means that either some operators cannot be allowed to attend a course when it is scheduled, or else each operator can only be allowed to attend a portion of course, and return to the TOC to provide operational support during the other time. NHI does require a minimum number of registrants in order to agree to provide instructors and materials for the course. This creates further scheduling difficulties.

The above issues notwithstanding, NHI does offer several courses that could be of value to TOC operators, particularly those who do not have specific transportation operations background. Courses of particular relevance are as follows:

Highway Capacity and Quality of Flow (133005A)

This course provides basic instruction in the use of the 2000 Highway Capacity Manual (HCM). Software is employed in most of the capacity analyses performed in the course.

Approximately one-half of the course is dedicated to sessions on interrupted flow facilities (i.e., signalized intersections, unsignalized intersections and arterials). The remainder of the course covers freeways, weaving sections, ramps, multilane, and two-lane rural facilities. The course includes lectures describing the procedures for performing capacity analyses on each type of highway facility. Demonstrations and hands-on application of the highway capacity software are used to solve example and workshop problems.

The hosting organization is responsible for providing computers with 133 MHz Intel Pentium III or faster processors with Windows 95, NT or better, color monitors, 20 MB of available disk space and a minimum of 16 MB RAM.

Freeway Traffic Operations (133075A)

The purpose of the Freeway Management and Operations training course is to provide participants with an appreciation of the key policies, institutional issues, challenges and barriers, technical and other issues to consider in the planning, design, implementation, management, operation, evaluation, and marketing of freeway facilities. The course has recently been updated to utilize the new *Freeway Management Handbook* as a reference document. ⁽¹³⁾

Managing Traffic Incident and Roadway Emergencies (133048A)

This course addresses institutional and technical aspects of safe and efficient resolution of traffic incidents and other roadway emergencies. The course focuses on practices to obtain good inter-agency and inter-disciplinary understanding and cooperation. Persons at mid or upper-management levels in various agencies who direct the resources of their agencies at the scene of a traffic incident or in response to an incident should attend. Agencies which should be represented at workshops include: law enforcement, fire and rescue (including emergency medical), emergency communications, transportation (including traffic management and highway maintenance), planning, towing and recovery, traffic reporting media, hazardous materials contractors and other emergency management personnel responding to traffic emergencies on freeways and arterial streets. While it is unlikely that NJDOT would host such a course specifically for the purposes of training its TOC operators, the opportunity for operators to attend such a course should it be offered (because NJDOT TOC managers or other agencies in the region decided to put it on) may exist.

CONSORTIUM FOR ITS TRAINING AND EDUCATION (CITE)

The Consortium for ITS Training and Education (CITE) is a unique organization of universities and industry associations focused on providing comprehensive advanced transportation training and education. ⁽¹⁴⁾ The purpose of CITE is to create an

integrated advanced transportation training and education program. The program, based on a consortium of universities, is open to anyone pursuing a career in advanced transportation. To date, CITE has developed over two dozen interactive web-based courses and offers three advanced transportation certificates. CITE offers courses for transportation technicians, professionals and college students. The interactive web-based courses do help address the issue of training versus maintaining TOC operation that is problematic with traditional NHI course type arrangements. However, the CITE courses have less of a track record with regards to training and its ultimate effectiveness in developing a more effective workforce. Courses identified as important to TOC operator development are as follows.

Incident and Emergency Management

Incident and emergency management is one of the areas that has received numerous benefits from applying ITS. Incidents contribute nearly 60 percent of annual roadway congestion and thus should be detected, verified, responded to, and cleared as quickly as possible. The importance of Incident and Emergency Management is at the basis of this course, in which incident characteristics and impact, incident detection, emergency response, site management, and allocation of resources are discussed at length. The material presented is further illustrated by the case-studies of incident management programs around the country. At the conclusion of this module students should be able to:

- Discuss why incident management and emergency management are necessary;
- List incident detection methods that can be used for freeway systems;
- Identify some problems existing in the development of incident detection algorithms;
- Discuss emergency response, site management, and incident clearance strategies; and
- Describe motorist information technologies.

The Tools of Advanced Transportation Management Systems (ATMS)

ATMS is the basic building block of ITS and cannot be deployed without enabling tools and technologies. Based on a systems engineering approach to the deployment of an ITS project, it is necessary to determine the technologies to be implemented after identifying problems, goals and objectives, functions to be performed, and architecture for the system. Particular emphasis is placed upon traffic surveillance technologies (vehicle detection) and variable message signs. At the conclusion of this module students should be able to:

- Explain the operating principles for each tool of ATMS, and
- Discuss the advantages and disadvantages of each tool of ATMS .

Traffic Flow Theory as Applied to ITS

Traffic flow theories aim to describe in a precise way the interactions between the vehicles, their operators and the roadway system. As such, these theories are an indispensable component for all models and tools that are being used in the design and operation of streets and highways. A number of theoretical approaches to traffic flow using a mathematical approach are examined in this course. At the conclusion of this session the student should be able to:

- Identify the relationship among the basic traffic stream characteristics;
- Select and design a traffic surveillance system for measuring traffic, and calculate from raw field data the traffic stream characteristics;
- Select the appropriate traffic stream model to analyze different traffic conditions;
- Explain in simple terms the mechanics of the driving task of car following;
- Explain the interactions among traffic streams at unsignalized intersections and merge/diverge points;
- Explain how traffic stream models can be used in the ITS environment (i.e. automated highways; advanced traffic management and control, etc.).

Signal Timing Concepts

This course gives the student an overview of the terms associated with signal timing; discusses the concepts of cycle length, split, offset, mid-block friction, phase sequences, the signal timing process, and signal timing optimization; and looks at the types of actuated controllers, passage time, extension, and the coordination of actuated and pre-timed controllers. At the conclusion of this module students should be able to:

- Define the terms used to evaluate the effectiveness of traffic signal control,
- Identify the different types of traffic control signals and their operating characteristic, and
- Discuss the fundamental concepts underlying traffic control signal timing.

NJDOP HUMAN RESOURCES DEVELOPMENT INSTITUTE (HRDI)

The NJDOP Human Resource Development Institute (HRDI) provides organizations with the services that are most relevant to enhancing and increasing knowledge, skills and abilities through competency based services. ⁽¹⁵⁾ HRDI offers a broad spectrum of training and consultation services to all levels of staff in the areas of computers, management and supervision, leadership, professional enrichment, communication and human resource management. These programs are offered at the NJDOP facility in Trenton or classes can be conducted on-site. Courses that most directly address the training needs identified in the FHWA *Guidelines* are described below.

Advanced Communication Skills

The ability of the manager to communicate effectively is critical to his/her success. This one day workshop is intended to help the manager/supervisor communicate effectively in the business environment. Topics that are explored include how mental models and moods effect communication, how to negotiate win-win solutions and how to get the results wanted through effective speaking and listening. In this course, participants will learn to:

- Describe how assumptions, perceptions, and moods affect styles of communication;
- Demonstrate how to negotiate no-lose/win-win situations; and
- Demonstrate an improved ability to get results through effective listening and speaking.

Dealing with Difficult People

This program is designed to assist individuals in dealing more effectively with the “difficult” person. The course begins with a discussion and description of four categories of people and their corresponding behaviors. From that point, the trainees explore what happens to these people under stress and various techniques to successfully cope with difficult behavior. The trainee has the opportunity to develop an individualized plan for coping with the most difficult person. Specifically, the course participant learns the following:

- How four basic personality types contribute to the success of the work group,
- Strategies for working with four basic personality types, and
- The importance of good communication skills in dealing with difficult people.

Enhancing Creativity in the Workplace

This program is designed to debunk the myth that the creative process is mysterious and relegated to a special few. Through lecture, video and exercises, supervisors and managers are taught how to be more creative in their organizations and how to accelerate and direct creativity in their organizations toward desired ends. Completion requires active participation in classroom exercises and the creation of a design to increase creativity in the workplace.

New Methods in Problem Solving and Decision Making

This course is designed to enable the participant to use the latest critical thinking skills needed to solve problems and make decisions. Students also learn methods to improve team efforts at problem solving and decision making. Participants learn to

make a distinction between a problem and a decision, apply a systematic approach to problem solving, demonstrate a systematic approach to making and implementing decisions, and identify the methods to improving team efforts at problem solving and decision making.

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5. RECOMMENDATIONS

The NJDOT TOCs serve a vital role in maximizing mobility of travelers throughout New Jersey and the entire Northeast Corridor. Decisions made and actions taken by TOC operators directly influence the operational efficiency of the roadway system in the region, and affect the overall levels of public opinion of NJDOT. Having a competent, qualified, and motivated TOC workforce is therefore essential if these centers are to continue to be successful in the future.

Similar to agencies operating TOCs in other parts of the country, though, the NJDOT has experienced some difficulties in continuing to meet the staffing needs of its centers. The functions and tasks typically performed in a TOC require staff with knowledge, skills, and abilities outside the range of existing employee title structures, position descriptions, and salary levels available within the department. At the same time, the continuous (or nearly so) operation of a TOC means that staff are typically faced with non-standard and sometimes varying shift schedules, periods of intense work activity during major incident conditions and such, as well as periods of fairly light work that can potentially result in periods of operator boredom.

Because of these unique challenges, NJDOT contracted with the Texas Transportation Institute (TTI) to assess and recommend ways that the agency could improve hiring and maintaining adequate levels of staffing with the required knowledge, skills, and abilities in its TOCs. The researchers' recommendations resulting from that assessment are as follows.

- New positions should be established specifically for traffic operations center operators in New Jersey.
- The salary structure for entry-level TOC operators should meet or exceed \$27,100, as agencies that utilize pay scales below this value reported having significant difficulties attracting and retaining operators in their TOCs.
- NJDOT TOCs should strive to maintain staffing levels at one operator for every 26 centerline miles of roadway responsibility in the TOC per 40 hours of operation per week, or one operator for every 15 variable message signs of responsibility per 40 hours of TOC operation per week.
- Available National Highway Institute (NHI) courses should not be actively pursued as part of TOC operator development, but be considered for operator attendance if they are brought to New Jersey by another group within NJDOT and opened up to other employees.
- Also, NJDOT TOC supervisor personnel should consider enrolling some of their existing operators in on-line and CD-ROM courses offered through the Consortium for ITS Training and Education (CITE) courses to determine their usefulness to operator development.

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APPENDIX A

STATE TOC TELEPHONE INTERVIEW SURVEY QUESTIONS

Description of Traffic Operation Center and Traffic Management System

Approximate size of operations center
Size of staff (operators, supervisors, and managers)
Number of centerline miles under surveillance
Number of freeways under surveillance
Number of VMS operated at the TOC
Times of operations, shifts and staffing
Duties and responsibilities of operators, supervisors, managers

Operator Recruitment, Qualifications, and Pay

What do you consider to be the most critical issues with respect to hiring and keeping qualified operators?
What are the necessary qualifications for new operators?
What are the necessary/desirable education requirements for operators?
What title/classification is used for operators?
What is the pay for operators?
Is the pay scale inconsistent with complexity of operator activities?
What other classifications have the same pay scale, lower pay scale, and higher pay scale as operators?
How and what type of persons do you recruit for operators?
Do operators normally come from within or outside of the organization?
What institutional and/or union issues help or hinder your ability to hire and keep qualified operators?
Where and how do you advertise for new operators?
What type of perks do you include in your advertisements?

Operator Turnover

Do you experience problems in keeping qualified operators? Is the turnover high?
If yes, what do you do to keep qualified operators? What financial, educational, and career incentives are available?
What are reasons that operators leave?
Do the times of your operations shifts adversely affect operator retention or hiring?
What can be done to address the problem of high turnover in general?

Operator Skills, Training, and Performance

What are the essential skills for good operators?
What type of training is necessary for operators?
What type of training do you provide operators? When in their careers? How often?

How do you assess operator performance?

Do you have a process or system to evaluate operator performance?

Shift Supervisor/Manager Skills, Training and Performance

What are the essential skills for good shift supervisors and managers?

What type of training is necessary for shift supervisors and managers?

What type of training do you provide shift supervisors and managers? When in their careers? How often?

How do you assess performance of shift supervisors and managers?

Do you have a process or system to evaluate supervisor and manager performance?

TOC Engineering Skills and Training

What are the essential skills for TOC engineers?

What type of training is necessary for TOC engineers?

What type of training do you provide TOC engineers? When in their careers? How often?

APPENDIX B

Entry-Level Operator Knowledge, Skill, and Ability (KSA) Requirements

| <i>Requirement</i> | <i>Knowledge</i> | <i>Skill</i> | <i>Ability</i> |
|--|---|--|---|
| Utilize GUI at MKV workstation. | Operation of a standard computer workstation in a windowing applications environment. Response to system queries and messages. Use of menus. Data entry and standard field editing. Understanding of real time device control and command execution. | Navigate between four or more multiple open application windows. Data entry of 40 WPM with 97% accuracy. Use of available macros to accelerate editing of data fields. Execute single control command for a single, or up to x multiple devices (depends on ATMS software). | Comprehend and read English as demonstrated by successful completion of 10 th grade English course. Mastery of the Microsoft Windows Operating System. Minimum of High School Education with 2 years of on-the-job experience using computers or 4 year college degree. |
| Obtain Visual Information from Display Wall. | Use of highway maps, outdoor and indoor video image displays, graphical text data, icons, and transportation. | Match CCTV video camera orientation with static images to determine the orientation of the roadway in the field of view. Read character text information. Note changed, unusual conditions or appearance of emergency icons within 15seconds. | Understand traffic information from visual sources in a transportation schematic. Ability is demonstrated by 4 years of experience on x roadway systems, advanced map reading level as demonstrated by experience as either EMT driver or US Army PFC, and 2020 correctable vision. |
| Read, understand, and act in accordance with agency policies and procedures. | Know public policy principles including customer service, regulation, enforcement, liability, accountability, responsibility, information dissemination, controlled conduct. | Perform duties consistent with agency policies. Correctly identify situations not conforming to these policies and notify supervisor within 2 minutes. Remember or find reference material on policies within 2 minutes. | Memorize 3 pages of bulleted text material on policies related to job duties. 4 years experience on-the-job in position requiring adherence to policy and procedure or four year college education. |
| Read, understand and perform procedures in System Operator Manual. | Know GUI Procedures. Understand operating system, application, and data base levels. | Implement error free procedures within 2 attempts. | Comprehend and read English as demonstrated by successful completion of 10 th grade English course. Ability to read and interpret technical data related to computers and software. Ability to follow written instructions with minimal supervision under time pressure. |

| <i>Requirement</i> | <i>Knowledge</i> | <i>Skill</i> | <i>Ability</i> |
|---|---|---|--|
| Verbally communicate to coordinate activities with other TMC operators and supervisors. | Knowledge of appropriate language and interpersonal communication (listening and speaking) used to conduct commonly used, business-related oral communications. | Communicate effectively, capturing and conveying important information while minimizing superfluous verbiage, slang, and lost data. | Work closely and cooperatively with others in a professional business environment as demonstrated by 2 years participating in goal directed teams. Ability to perform under pressure, including when communications are recorded for third party review. |
| View Traffic Data. | Traffic flow characteristics such as speed, velocity, volume, average speed, density, percent occupancy, demand, and capacity. | Determine if data viewed is abnormal, anomalous, within or outside a range or threshold. | Correctly interpret data assembled in a two-dimensional array format as demonstrated by successful completion of 10 th grade level high school mathematics, and completion of college level course material on highway capacity, NHI training, or specialized training in freeway flow. Alternatively, a four year engineering degree in Transportation, Civil (w/transportation courses), or Traffic Engineering. Alternatively, 2 years experience in a TMC utilizing traffic flow parameters, and demonstrated ability. |
| View Video Images. | Stationary and moving object recognition in a two (2) dimensional representation of a three (3) dimensional field of view. | Determine if image objects viewed are abnormal, anomalous, and reflect any danger to safe and efficient transportation. Daytime and nighttime operation skills required. Demonstrated skill level to detect a single event in 6 images, in 10 seconds. | Scan multiple monitors and note changes over time to objects and images as demonstrated by 2 years experience in a multi-monitor environment, or demonstrated ability. |
| Detect Events (video images, audible sources [radio monitoring, telephone notification], ATMS generated Incident Detection Alarms (audible or visible). | Roadway geometry and lane configuration, direction, coordinates, links, nodes, zones, sections, mileposts, station numbering. General SCADA alarm principles. | Work two consecutive hours with sufficient focus to respond to all alarms received in less than 10 seconds for each alarm. Work two consecutive hours with 100% accuracy taking note of randomly recurring events, at the rate of at least 20 events per hour. | 2 years experience on-the-job with automated alarms in a SCADA work environment, dispatch center, or similar facility, and demonstrated skill level. Alternatively, two weeks of ATMS software training on simulator with two hour focus periods, and/or a four year engineering degree. |

| <i>Requirement</i> | <i>Knowledge</i> | <i>Skill</i> | <i>Ability</i> |
|--|--|---|--|
| Coordinate with interagency traffic management personnel during confirmed incidents. | If radio console use is required, knowledge of radio call signs and protocols is required. Traffic law and incident management policies for DOT and responders including police agencies. Local political jurisdictions and institutional relationships. Knowledge of Incident Command System (ICS) in use. Complete response to inquiries in less than three minutes. | Memorize all required call signs and policies. Low violation rate of protocols. | If co-located with police, security clearance and background check is required, no felony convictions. |
| Respond to public inquiries: Examples are taking cell phone calls for travel assistance directly from travelers. | (G1-6), and customer service practices. Origins and destinations in the covered areas, knowledge of the roadway network and travel conditions by time of day. | Provide effective route information to aid motorist in reaching destination in a courteous and professional manner. | 2 years experience on-the-job with ATIS systems or in TMC or broadcast media work environment, dispatch center, or similar facility, or four year education. Customer service training requisite for information service provider industry. |

Fully-Trained Operator Knowledge, Skill, and Ability (KSA) Requirements

| <i>Requirement</i> | <i>Knowledge</i> | <i>Skill</i> | <i>Ability</i> |
|--|--|---|--|
| Utilize GUI at MKV workstation. | <p>Operation of a standard computer workstation in a windowing applications environment.</p> <p>Response to system queries and messages. Use of menus.</p> <p>Data entry and standard field editing.</p> <p>Understanding of real time device control and command execution.</p> | <p>Navigate between four or more multiple open application windows.</p> <p>Data entry of 40 WPM with 97% accuracy.</p> <p>Use of available macros to accelerate editing of data fields.</p> <p>Execute single control command for a single, or up to 3 multiple devices (depends on ATMS software).</p> | <p>Comprehend and read English as demonstrated by successful completion of 10th grade English course.</p> <p>Mastery of the Microsoft Windows Operating System.</p> <p>Minimum of High School Education with 2 years of on-the-job experience using computers or 4 year college degree.</p> |
| Utilize Multi-channel Telephone and Radio Headset. | <p>Operation of hold, transfer, speak, listen, speed dial, and other standard business telephone headset features.</p> <p>Operation of channeled two way radio headset with selectable frequencies.</p> | <p>Listen to, and correctly interpret, information from callers, including police dispatchers, other TMC operators, and the public.</p> <p>Ability to convey important information succinctly with minimal verbiage.</p> <p>Quickly switch between lines without lost calls, use speed and multi-channel dialing.</p> | <p>Comprehend and read English as demonstrated by successful completion of 10th grade English course.</p> <p>Ability to articulate and speak clearly as demonstrated by 2 years of job experience using a multi-channel business telephone set.</p> |
| Obtain Visual Information from Display Wall. | <p>Use of highway maps, outdoor and indoor video image displays, graphical text data, icons, and transportation.</p> | <p>Match CCTV video camera orientation with static images to determine the orientation of the roadway in the field of view.</p> <p>Read character text information.</p> <p>Note changed, unusual conditions or appearance of emergency icons within 15seconds.</p> | <p>Understand traffic information from visual sources in a transportation schematic. Ability is demonstrated by 4 years of experience on 2 roadway systems, advanced map reading level as demonstrated by experience as either EMT driver or US Army PFC, and 20/20 correctable vision.</p> |

| <i>Requirement</i> | <i>Knowledge</i> | <i>Skill</i> | <i>Ability</i> |
|---|--|---|---|
| Read, understand, and act in accordance with agency policies and procedures. | Know public policy principles including customer service, regulation, enforcement, liability, accountability, responsibility, information dissemination, controlled conduct. | Perform duties consistent with agency policies. Can correctly identify situations not conforming to these policies and notify supervisor within 2 minutes. Remember or find reference material on policies within 2 minutes. | Memorize 3 pages of bulleted text material on policies related to job duties. 4 years experience on-the-job in position requiring adherence to policy and procedure or four year college education. |
| Read, understand and perform procedures in System Operator Manual. | Know GUI Procedures. Understand operating system, application, and data base levels. | Implement error free procedures within 2 attempts. | Comprehend and read English as demonstrated by successful completion of 10 th grade English course. Ability to read and interpret technical data related to computers and software. Ability to follow written instructions with minimal supervision under time pressure. |
| Verbally communicate to coordinate activities with other TMC operators and supervisors. | Knowledge of appropriate language and interpersonal communication (listening and speaking) used to conduct commonly used, business-related oral communications. | Communicate effectively, capturing and conveying important information while minimizing superfluous verbiage, slang, and lost data. | Work closely and cooperatively with others in a professional business environment as demonstrated by 2 years participating in goal directed teams. Ability to perform under pressure, including when communications are recorded for third party review. |
| View Traffic Data. | Traffic flow characteristics such as speed, velocity, volume, average speed, density, percent occupancy, demand, and capacity. | Determine if data viewed is abnormal, anomalous, within or outside a range of threshold. | Correctly interpret data assembled in a two-dimensional array format as demonstrated by successful completion of 10 th grade level high school mathematics, and completion of college level course material on highway capacity, NHI training, or specialized training in freeway flow. Alternatively, a four year engineering degree in Transportation, Civil (w/transportation courses), or Traffic Engineering. Alternatively, 2 years experience in a TMC utilizing traffic flow parameters, and demonstrated ability. |

| <i>Requirement</i> | <i>Knowledge</i> | <i>Skill</i> | <i>Ability</i> |
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| View Video Images. | Stationary and moving object recognition in a two (2) dimensional representation of a three (3) dimensional field of view. | Determine if image objects viewed are abnormal, anomalous, and reflect any danger to safe and efficient transportation. Daytime and nighttime operation skills required. Demonstrated skill level to detect a single event in 6 images, in 10 seconds. | Scan multiple monitors and note changes over time to objects and images as demonstrated by 2 years experience in a multi-monitor environment, or demonstrated ability. |
| View Weather Data. | Impact of adverse weather on transportation systems, including wind, precipitation, temperature extremes, and airborne particulates including smog, fog, smoke, and precipitation. | Anticipate safety and traffic flow implications of weather fluctuations and events. Recognize values out of acceptable ranges. | Understand how weather systems function as demonstrated by successful completion of courses of general or earth science at x level (default is 10 th grade), combined with RWIS vendor training in weather systems, or four year engineering degree. |
| View Emissions Data. | General air quality principles regarding particulate content in parts per million. Familiarity with common airborne toxins. | Anticipate safety and traffic flow implications of emissions fluctuations and events. Recognize values out of acceptable ranges. | Understand how emissions, fog, smoke impair air quality as demonstrated by successful completion of courses of Chemistry or Biology sciences at undergraduate 4 year college. |
| Detect Events (video images, audible sources [radio monitoring, telephone notification], ATMS generated Incident Detection Alarms (audible and/or visible). | Roadway geometry and lane configuration, direction, coordinates, links, nodes, zones, sections, mileposts, station numbering. General SCADA alarm principles. | Work two consecutive hours with sufficient focus to respond to all alarms received in less than 10 seconds for each alarm. Work two consecutive hours with 100% accuracy taking note of randomly recurring events, at the rate of at least 20 events per hour. | 2 years experience on-the-job with automated alarms in a SCADA work environment, dispatch center, or similar facility, and demonstrated skill level. Alternatively, two weeks of ATMS software training on simulator with two hour focus periods, and/or a four year engineering degree. |

| <i>Requirement</i> | <i>Knowledge</i> | <i>Skill</i> | <i>Ability</i> |
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| Verification using CCTV. (Establish precise location data; determine revised lane configuration; classify as property damage, injury, spilled load, HAZMAT, fire, type and number of vehicles, overturned truck, etc; complete initial incident form; clear if false alarm.) | Camera locations and orientation. PTZ camera controls. Knowledge of pre-sets, iris functions, and white balance. | Select camera, locate, and zoom in on incident in 360 degree field of view with dome type PTZ in 12 seconds or less. Select camera, locate, and zoom in on incident in 360 degree field of view with rotating enclosure drive type PTZ in 30 seconds or less. | 2 years experience on-the-job with CCTV systems in TMC or security or broadcast media work environment, dispatch center, or similar facility, or four year education. |
| Event Response. (Narrow-casting incident data to required responders based upon event classification; establish or confirm system generated duration estimate based upon knowledge of typical event durations. Implement ITS advisory roadside devices and sub-systems to improve responder safety and mitigate travel. Provide Service Patrols with incident information. | Knowledge of likely duration for response and cleanup of incidents by classification type. Data fusion methods to create standardized message sets related to the event. | Complete initial required response to multiple minor incidents within 10 minutes, a major incident within 5 minutes. Complete entire response action to any roadway vehicular accident within an additional 5 minutes. Take precautions to prevent secondary incidents within an additional 5 minutes. | 2 years experience on-the-job with incident management in an emergency response, police, fire, service patrol, or military work environment, dispatch center, or similar facility. Alternatively, advanced EMT training or 4 year education with major coursework in transportation or emergency preparedness and response. |

| <i>Requirement</i> | <i>Knowledge</i> | <i>Skill</i> | <i>Ability</i> |
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| Coordinate with interagency traffic management personnel during confirmed incidents. | Knowledge of radio call signs and protocols, traffic law and incident management policies for DOT and responders including police agencies, local political jurisdictions, and institutional relationships. Knowledge of Incident Command System (ICS) in use. | Memorize all required call signs and policies. Low violation rate of protocols. | If co-located with police, security clearance and background check is required, no felony convictions. |
| Regulatory Device Operation: Adjust Traffic Signal Timings in response to incident. | Theory of operation including transition and safety measures. Split, cycle, offset, detectorization and coordination, timing plans, zones, master/slave concepts, saturation, transition cycles. Capacity utilization and flow characteristics, queuing. Selection of traffic signal timing plans. | Skill in using regulatory devices is based upon safety, and devices must be used in a safe manner. | Utilization of traffic signal regulatory devices requires a four year college degree in a technical or scientific field with a concentration in traffic engineering, or 10 years experience in traffic control with a government agency or traffic control equipment vendor. |
| Regulatory Device Operation: Activate Regulatory DMS in response to incident, or to support reversible or HOV operation. Open/close gates. | Theory of operation for variable speed limit, lane closure, ramp closure, and/or road closure for highways, tunnels, and bridges. | Skill in using regulatory devices is based upon safety, and devices must be used in a safe manner. | Utilization of traffic signal regulatory devices requires a four year college degree in a technical or scientific field with a concentration in traffic engineering, or 10 years experience in traffic control with a government agency or traffic control equipment vendor. |

| <i>Requirement</i> | <i>Knowledge</i> | <i>Skill</i> | <i>Ability</i> |
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| Monitor Incident. (Observe traffic data and video images and update response plan as lane configurations and incident site conditions change.; observe the queue to detect secondary incidents; update response duration estimate as appropriate; initiate secondary notifications if observed conditions change; hand off incident if shift change occurs; observe traffic data and video images to determine roadway recovery and clear response plan as appropriate. | <p>Camera locations and orientation. PTZ camera controls. Knowledge of pre-sets, iris functions, and white balance.</p> <p>Knowledge of Incident Command System (ICS) in use.</p> <p>Knowledge of response plan generation and traffic management.</p> | <p>Select camera, locate, and zoom in on incident in 360 degree field of view with dome type PTZ in 12 seconds or less.</p> <p>Select camera, locate, and zoom in on incident in 360 degree field of view with rotating enclosure drive type PTZ in 30 seconds or less.</p> | <p>2 years experience on-the-job with incident management in an emergency response, police, fire, service patrol, or military work environment, dispatch center, or similar facility.</p> <p>Alternatively, advanced EMT training or 4 year education with major coursework in transportation or emergency preparedness and response.</p> |
| Acknowledge Detected Failures, Diagnose Failures, Implement Repairs, Dispatch/ notify traffic signal repair technician(s). | Theory regarding automatic retry of devices, data communications errors and error checking algorithms, MTBF data and diagnostic codes. | <p>Classifying failure events as repeated alarms for the same failed device, grouping similar events, determining if device failures are local device or communication failures, etc.</p> <p>Maintain a high number of operational devices, and only issue proper work orders to maintainers.</p> | Two year technical college degree in electronics, or four year college education in a technical or scientific field covering electronics, or four years of experience in a SCADA type work environment where monitored points issue failure alarms, or two years prior experience in a TMC having automated failure management. |

| <i>Requirement</i> | <i>Knowledge</i> | <i>Skill</i> | <i>Ability</i> |
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| Utilize Dynamic Message Signs in a System. | Texas Transportation Institute (TTI) and FHWA guidelines for creation of variable message sign text messages. Standard spell check routines. | Select DMS, or a group of DMS, and select data base messages for display within two minutes. Compose messages in the TTI / FHWA format quickly without spelling, syntax, or timing errors. | Demonstrated work experience in a position requiring compliance with policies for 2 years, without adverse incident. Work history indicating emotional stability, trustworthiness, and consistent performance in an increasingly responsible position without adverse incident. Four year engineering degree in Civil/transportation with concentration in traffic engineering. |
| Record HAR or 511 messages. | Operation of hold, transfer, speak, listen, speed dial, and other standard business telephone headset features. Operation of channeled two way radio headset with selectable frequencies. Emphasis on diction. | Select HAR, or a group of HARs, and record accurate and understandable voice messages for broadcast within five minutes. | Demonstrated work experience in a position requiring compliance with policies for 2 years, without adverse incident. Work history indicating emotional stability, trustworthiness, and consistent performance in an increasingly responsible position without adverse incident. Four year engineering degree in Civil/transportation with concentration in traffic engineering, or advanced training in HAR message generation. |
| Utilize ATIS. | Knowledge of data fusion methodology. | Keeping messages timely and accurate. Refresh multiple message sets on a 5 minute cycle. | 2 years experience on-the-job with ATIS systems in TMC or broadcast media work environment, dispatch center, or similar facility, or four year education. |
| Respond to public inquiries. | Customer service practices. Origins and destinations in the covered areas, knowledge of the roadway network and travel conditions by time of day. | Provide effective route information to aid motorist in reaching destination in a courteous and professional manner. Complete response to inquiries in less than three minutes. | 2 years experience on-the-job with ATIS systems or in TMC or broadcast media work environment, dispatch center, or similar facility, or four year education. Customer service training requisite for information service provider industry. |

| <i>Requirement</i> | <i>Knowledge</i> | <i>Skill</i> | <i>Ability</i> |
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| Acknowledge TMC software failures, look up error codes and diagnose failures, warm and cold restarts of systems, dispatch and notify computer hardware technician (s) when appropriate. | Specific knowledge in Operating systems software in use, networking at the system administrator level, data base and server maintenance. | Classifying failure events as repeated alarms for the same failed device, grouping similar events, determining if device failures are local device or communication failures, etc. Maintain a high number of operational devices, and only issue proper work orders to maintainers. | Two year technical college degree in networking and computer software and four years experience, or four year college education, in a technical or scientific field covering software and systems, or four years of experience in a TMC work environment with Integrated ITS subsystems. |
| Life-Safety Event Handling, regulatory device operation to prevent accidental loss of life. | Detailed theory of operation for overheight vehicles, rail grade crossing equipment, variable speed limit, lane closure, ramp closure, and/or road closure for highways, tunnels and bridges. | Skill in using regulatory devices in a safe manner. | Utilization of traffic signal regulatory devices requires a four year college degree in a technical or scientific field with a concentration in traffic engineering, and 10 years experience in life safety systems operation with a government agency or military. |