ACUITY PDH

CONTINUING EDUCATION FOR SURVEYORS AND ENGINEERS

# Surveying in High-Exposure Areas

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# Section 1 — Course Description

## Surveying in High-Exposure Areas

Land surveyors routinely work in environments that expose them to significant physical hazards. **Unlike most professions where risk is confined to a fixed workplace, surveying demands that crews operate in active roadways, on highway shoulders, within construction zones, along steep terrain, and in areas with limited sight distance and no physical barrier between personnel and moving traffic.** <u>The consequences of inadequate preparation in these environments are severe and, in many cases, fatal.</u>

This course addresses the safety disciplines that apply specifically to survey crews operating in high-exposure areas, with emphasis on lane and roadway work. The material is built around practical field application, not general safety theory. Licensed professionals who complete this course will come away with a structured framework for evaluating exposure, planning for hazard mitigation, coordinating with traffic control personnel, selecting and deploying personal protective equipment (PPE), and responding when conditions change unexpectedly in the field.

The course is designed for licensed Professional Land Surveyors (PLS) who either lead survey crews directly or are responsible for project planning and crew oversight. The content assumes familiarity with standard field survey operations. Basic surveying concepts are not defined or explained. The focus is entirely on the safety layer that must be applied when those operations occur in or adjacent to active traffic.

Topics covered include the hierarchy of exposure risk in roadway environments, the principles behind effective traffic control for survey operations, PPE selection and correct use in high-visibility applications, situational awareness and behavioral discipline in the field, and emergency response protocols specific to roadway incidents involving survey crews.

**This course is not a substitute for formal flagger certification or a traffic control management course. It is a professional-level treatment of the decision-making framework, risk assessment methodology, and crew leadership responsibilities that apply when surveyors work where vehicles are moving. Completion of this course qualifies for one professional development hour (PDH) of continuing education credit in the land surveying discipline.**

## Section 2 — Course Objectives

Upon completing this course, the participant will be able to:

1. Identify the categories of high-exposure work environments commonly encountered in land surveying and describe the risk factors specific to each.
2. Apply a structured risk assessment process to survey operations occurring in or adjacent to active roadways before mobilizing a crew.
3. Describe the core principles of temporary traffic control as they apply to survey crew protection, including the purpose and placement logic of advance warning, transition, and work space zones.
4. Select appropriate PPE for roadway survey conditions based on visibility requirements, traffic speed, and proximity to the travel lane.
5. Recognize behavioral and situational factors that increase crew exposure during field operations and apply corrective strategies to reduce that exposure.
6. Describe the roles and responsibilities of the crew chief and project surveyor of record in maintaining safety compliance on high-exposure survey assignments.
7. Identify the conditions that require a survey crew to cease operations and withdraw from a work area, and describe the process for doing so safely.
8. Explain the principles of emergency response applicable to roadway incidents involving survey personnel, including notification, crew accountability, and scene management before emergency responders arrive.
9. Evaluate a proposed field operation for safety deficiencies using a pre-task planning checklist approach.
10. Apply the concepts covered in this course to improve crew safety culture and reduce complacency in routine high-exposure survey assignments.

# Section 3 — Table of Contents

## Section 4 — Introduction

Land surveying has always carried physical risk. The nature of the work places crews in locations that most people avoid by design (the edge of a highway shoulder, the middle of an intersection, the travel lane of a road that has not been closed). Surveyors go where the work is, and the work is frequently where traffic is moving. That reality has not changed, but the traffic environment surrounding it has. Vehicle speeds have increased on many corridor types, driver distraction has become a documented and pervasive problem, and the volume of traffic on both urban and rural roadways has grown substantially over the past several decades. The survey crew standing on a highway shoulder today faces a materially different risk profile than a crew doing the same work thirty years ago.

Despite that shift, safety culture within the surveying profession has not always kept pace. Complacency is one of the most consistently cited factors in roadway worker fatalities, and survey crews are not immune to it. Repetitive exposure to a hazard tends to normalize it. A crew that runs highway centerline every week without incident begins to move through the setup process on autopilot. Cones go out the same way every time. The crew chief stops actively scanning traffic because nothing bad has happened yet. That normalization is not a character flaw. It is a predictable human response to routine. But in a high-exposure environment, routine is exactly when vigilance needs to be highest, because the hazard does not become smaller just because it has not materialized.

The roadway environment is also not static. A setup that was adequate at the start of a shift may become inadequate as conditions change. Traffic volume increases during peak hours. Light conditions shift as the sun moves and shadows lengthen. A work zone that was fully visible to approaching drivers in the morning may be directly in a sun glare corridor by midafternoon. Wind moves cones and signage. A flagging operation that was staffed correctly at the outset becomes understaffed when a crew member leaves to retrieve equipment. These are not edge cases. They are predictable variables that occur on ordinary field days, and they require the person in charge to be actively monitoring the operation rather than simply executing a plan that was set at the beginning of the day.

This course is written for the licensed PLS who is responsible for field operations, whether that means standing in the road personally or directing others who do. The content is not aimed at entry-level crew members learning the basics of flagging or traffic control device placement. Those topics require hands-on, task-specific training that a text-based continuing education course cannot replicate. What this course addresses is the decision-making layer that sits above those tasks including the risk assessment process, the planning obligations, the crew leadership responsibilities, and the behavioral disciplines that determine whether a field operation is run safely or whether it is run on habit and hope.

It is also worth stating clearly what this course does not attempt to do. It does not provide a comprehensive treatment of traffic control device standards, warrants, or design. It does not address the full scope of occupational safety regulations that may apply to survey operations in a given jurisdiction. It does not replace agency-specific training requirements or permit conditions that may govern work in a particular right of way (ROW). What it does is equip the licensed PLS with a professional-level understanding of the risk factors, planning obligations, and field leadership practices that are most directly linked to crew safety outcomes in high-exposure survey environments.

The structure of the course moves from exposure and risk context, into planning and traffic control principles, through equipment and awareness in the field, and closes with emergency response and leadership. Each section builds on the previous one. A surveyor who understands why certain environments are dangerous is better positioned to plan effectively for them. A surveyor who plans effectively is better positioned to deploy traffic control correctly. A surveyor who understands traffic control is better positioned to recognize when something in the field has deviated from the plan and act accordingly.

One concept runs through every section of this course: the gap between a safe operation and an unsafe one is almost always a decision, not an accident. Most roadway incidents involving survey crews are preceded by a series of smaller choices including to skip a step in the setup, to keep working when conditions changed, to assume that drivers would behave predictably, to defer a safety conversation because the schedule was tight. Those choices are made by people, which means they can be made differently. The purpose of this course is to give the licensed PLS a clearer framework for making them differently, consistently, before something goes wrong rather than after.

It is also worth addressing the professional responsibility dimension directly. The PLS who signs and seals a survey is accountable for the work product. That accountability extends to the conditions under which the work was collected. A boundary survey conducted under unsafe field conditions is not just a liability exposure for the firm, it reflects on the professional judgment of the surveyor of record. Courts and licensing boards have both treated field safety failures as professional conduct issues, not merely operational ones. The licensed PLS has an obligation to the crew, to the client, and to the profession to ensure that the methods used to gather field data do not expose workers to unreasonable and unmitigated risk.

Surveying in active traffic is a legitimate, necessary professional activity that can be conducted safely when it is planned deliberately and executed with discipline. The crews that work in high-exposure areas without incident over long careers are not lucky. They are methodical. They treat the pre-task planning process seriously. They establish clear communication protocols before the crew leaves the truck. They know exactly what conditions will cause them to stop work and pull out, and they do not negotiate with those conditions when they arise. That level of operational discipline is learnable and transferable. This course is one step toward building it.

## Section 5 — Understanding Exposure: How Surveyors Get Hurt and Why

The starting point for any serious discussion of surveyor safety is an honest accounting of how injuries and fatalities actually occur. Abstract warnings about working near traffic do not change behavior. What changes behavior is a clear-eyed understanding of the specific mechanisms by which surveyors get hurt, the environmental and operational conditions that make those mechanisms more likely, and the patterns that appear repeatedly across incidents when the details are examined carefully.

**The term exposure, as used throughout this course, refers to the degree to which a person or crew is positioned in a location where a hazardous event could cause injury or death.** Exposure is not binary. It exists on a continuum, and it is influenced by a combination of factors including physical proximity to the hazard, duration of time spent in that proximity, the speed and volume of traffic in the area, sight distance conditions, and the adequacy of protective measures in place. A crew working six inches from the fog line on a 70-mile-per-hour interstate for four hours with no traffic control has extreme exposure. A crew working fifty feet off the pavement on a low-volume county road with a posted speed of 25 miles per hour has minimal exposure, comparatively speaking of course. Most survey operations fall somewhere between those two poles, and the job of the surveyor is to accurately assess where on that continuum a given operation sits before the crew mobilizes.

### Categories of High-Exposure Survey Environments

Not all roadway survey work carries the same risk profile. Understanding the distinctions between environment types is the first step toward calibrating the response appropriately.

High-speed arterials and interstates represent the highest-risk category for most survey operations. Traffic moves fast, stopping distances are long, and drivers are often not expecting to encounter workers in or near the travel lane. On divided highways, the median itself can become a high-exposure area if crews must occupy it to run centerline or locate utilities. The combination of high speed, limited reaction time for drivers, and the physical vulnerability of survey crew members makes this environment the one that demands the most rigorous planning and the most robust traffic control. Operations on high-speed facilities also tend to generate strong turbulence as large vehicles pass at speed. That wind effect is enough to displace lightweight traffic control devices, and it creates a physical jolt for crew members standing close to the travel lane that can affect balance and instrument stability. Crews who have not experienced that effect before frequently underestimate it.

Urban intersections present a different but equally serious risk profile. Speed may be lower, but the complexity of the environment is significantly higher. Traffic comes from multiple directions. Turning movements create exposure angles that are difficult to anticipate and defend against. Pedestrian activity adds unpredictability. Signal timing creates gaps in traffic that are shorter and less consistent than on open roadways, which compresses the window available for safe crew positioning. Crews working in urban intersections are also frequently visible to a large number of drivers simultaneously, which can create driver confusion and erratic behavior as motorists attempt to navigate around an unexpected obstruction. The presence of a survey crew in an intersection also tends to generate driver curiosity, which itself is a distraction that increases the risk of a vehicle drifting toward the work area.

Construction zone surveys add another layer of complexity. When a survey crew is operating within an active construction zone, they are working in an environment that already has its own traffic control plan, its own crew movements, and its own set of hazards. The survey crew's presence represents an additional variable that the construction zone traffic control may not have been designed to accommodate. Equipment movement within the zone, blind spots created by construction vehicles, and the general noise and visual complexity of an active site all increase the difficulty of maintaining situational awareness. A survey crew operating in a construction zone must also contend with the reality that construction workers on site may not know who the surveyors are, what they are doing, or where they are going to be at any given moment. Establishing communication with the construction superintendent before beginning work in an active zone is a basic coordination requirement, not an optional courtesy, and it directly affects crew safety.

Rural two-lane roads are frequently underestimated as a risk environment. Lower traffic volumes create a false sense of security. But rural roads often have higher posted speeds, limited shoulder width, no physical barrier between the travel lane and the survey crew, and sight distances that are compromised by horizontal and vertical curves. A driver cresting a hill at 55 miles per hour has very little time to react to a survey crew in the roadway, particularly if that crew is not immediately recognizable as a work zone. Vegetation, topography, and the absence of streetlighting further reduce visibility in early morning or late afternoon operations. Gravel shoulders on rural roads present an additional footing hazard, and drainage ditches immediately adjacent to the shoulder create a fall risk if a crew member steps back quickly to avoid a passing vehicle.

Bridge and overpass surveys occupy their own risk category. The confined geometry of a bridge deck or overpass structure eliminates the option of stepping off the road surface. There is no shoulder to retreat to. Traffic is channelized and moving at speed, and the survey crew has nowhere to go if a vehicle drifts or loses control. Wind exposure on elevated structures is also higher, which affects both crew stability and the behavior of traffic control devices. Any survey operation on a bridge or overpass structure should be treated as a maximum-exposure environment regardless of traffic volume. Work on bridge structures also frequently requires leaning over railings or reaching beyond guardrail faces to access measurement points, which introduces a fall-to-water or fall-to-grade hazard that is entirely separate from the traffic exposure.

Night and low-light operations represent an underappreciated category of elevated risk. Survey work occasionally must be performed at night to minimize traffic disruption, particularly on high-volume corridors where daytime lane closures are not practical. The reduced visibility cuts both ways (drivers have less time to see and react to the work zone, and crew members have less ability to monitor approaching traffic). Retroreflective properties of PPE and traffic control devices become critical in low-light conditions in ways that do not fully apply during daylight hours. A device that is highly visible in daylight can lose much of that visibility under headlight illumination alone, particularly as the material ages and accumulates dirt and wear. Crew members working at night must also contend with the effects of fatigue associated with working outside their normal schedule, which compounds the cognitive demands of an already high-exposure environment.

## How Incidents Happen

Across the body of roadway worker incident data that has been compiled over several decades, a small number of causal patterns appear with enough consistency to be treated as primary risk drivers rather than anomalies.

Struck-by events are the dominant mechanism of injury and fatality for roadway workers including surveyors. A struck-by event occurs when a moving vehicle contacts a worker or a piece of equipment in the work area. The vehicle may be traveling in the normal traffic stream, or it may be a construction vehicle operating within the work zone. In the survey context, struck-by events most commonly occur when a crew member is focused on an instrument or a data collector and is not actively monitoring approaching traffic, when a vehicle fails to yield to traffic control, or when visibility conditions have degraded to the point that the crew is not visible to drivers with adequate reaction time.

The reaction time problem deserves specific attention. At 60 miles per hour, a vehicle is covering approximately 88 feet per second. If a driver first becomes aware of a work zone at 200 feet, that driver has roughly 2.3 seconds to perceive the situation, make a decision, and execute a response. That window is not adequate for a driver who is distracted, impaired, or simply not expecting a work zone in that location. The practical implication for survey crews is that high-visibility positioning and advance warning are not courtesies extended to drivers. They are survival requirements for the crew.

Backing vehicle incidents are a significant and often overlooked hazard in the survey context. Survey crews frequently work around their own vehicles, which are used as mobile equipment platforms and as partial physical buffers. When those vehicles are repositioned (moving forward to keep pace with the work, or backing to reach a new setup location) crew members on the ground are at risk if the driver does not have a clear picture of where everyone is standing. This is particularly acute when the survey vehicle is a larger truck or van with blind spots to the rear and sides. Establishing and enforcing a movement protocol for the crew vehicle is a basic but frequently skipped safety step. The protocol does not need to be elaborate. It simply needs to require that the driver confirms the location of all crew members before the vehicle moves, and that crew members on the ground acknowledge that they are clear of the vehicle before movement begins. That two-step confirmation eliminates a category of incident that should never occur.

Slip, trip, and fall incidents in the roadway environment carry consequences that would be minor in most other settings. A crew member who trips over a crack in the pavement or catches a foot on a raised edge in a parking lot might suffer a minor injury in low-traffic conditions. The same fall in a travel lane or on a bridge deck with live traffic creates an immediate and extreme secondary exposure. The ground surface in roadway environments is often irregular, marked with utility cuts, patched paving, drainage grates, and painted markings that can be slippery when wet. Crew members focused on instruments or field notes are not watching their footing, which increases the likelihood of a trip. The more useful fix is minimizing the time crew members spend in positions where a fall would place them directly in the path of traffic, not just watching one's footing. Route planning within the work zone, identifying where crew members will walk and stand before work begins, reduces this risk significantly.

Heat and fatigue are exposure multipliers that the profession has historically underweighted. A crew member who has been working in direct sun for six hours in high-humidity conditions is not performing at the same cognitive level as that same crew member at the start of the shift. Reaction time slows. Attention narrows. Decision-making degrades. In a high-exposure environment, the margin for cognitive error is small, and fatigue systematically erodes that margin. The crew chief who recognizes the signs of heat stress or fatigue in crew members and acts on that recognition is performing a direct safety function, not simply managing personnel comfort. Scheduling demanding high-exposure work for the cooler and lower-traffic periods of the day, building in mandatory rest and hydration breaks, and monitoring crew condition throughout the shift are operational decisions that directly affect safety outcomes.

Distraction-related incidents warrant separate treatment even though distraction is often a contributing factor in the incident types already described. The nature of survey work creates a structural distraction problem. An instrument operator running a traverse is, by definition, looking through an eyepiece or at a data collector screen. A crew member setting a monument is looking at the ground. A party chief reading a deed description is looking at paper. All of these activities require the crew member to direct attention away from the surrounding traffic environment at least intermittently. That intermittent inattention is not avoidable. It is inherent to performing the work. The response to it is not to tell crew members to pay better attention. The response is to design the operation so that the moments of inattention are as brief as possible, occur in the least exposed positions available, and are covered by another crew member or by traffic control that provides a physical and temporal buffer between the crew and approaching vehicles.

## The Role of Normalization in Incident Causation

**Perhaps the most insidious factor in survey crew incidents is normalization of deviance** (*a term used in safety science to describe the process by which repeated exposure to a risk, without a negative outcome, gradually causes that risk to be perceived as acceptable*). The crew that has run the same highway corridor a dozen times without a close call begins to treat that corridor as a routine job rather than a high-exposure environment. Setup steps get compressed. The pre-task safety discussion gets shorter and then disappears entirely. The crew chief stops actively assessing traffic conditions because the prior twelve trips went fine.

Normalization of deviance does not require negligence or bad faith. It is a natural product of experience in the absence of negative feedback. The correction for it is not simply telling crews to be more careful (that instruction has no lasting effect). The correction is a structured pre-task process that resets the assessment at the beginning of each operation, regardless of how many times the crew has done something similar before. Consistency in that process is the mechanism by which normalization is interrupted. When the pre-task assessment is treated as a real evaluation rather than a ritual, it forces the crew chief to look at current conditions rather than relying on memory of previous trips. Conditions change. Traffic patterns shift. Sight distances that were adequate in one season may be compromised in another by vegetation growth. The pre-task process catches those changes when it is done with genuine attention.

Understanding how and why surveyors get hurt is the foundation on which every subsequent planning and operational decision in this course is built, not an academic exercise for its own sake. A surveyor who can accurately characterize the exposure profile of a given operation, identify the most likely incident mechanisms for that environment, and name the behavioral and situational factors that increase risk is already operating at a higher safety standard than one who approaches every field day the same way regardless of conditions.

## Section 6 — Pre-Task Planning and Risk Assessment

The difference between a survey operation that is managed safely and one that is managed on instinct is almost always traceable to what happened before the crew left the office. Pre-task planning is not a bureaucratic requirement imposed from outside the profession. It is the mechanism by which the surveyor translates knowledge of the hazard environment into specific, actionable decisions about how the work will be conducted. A crew that arrives at a high-exposure site with a clear plan (who stands where, what traffic control is in place, what conditions trigger a work stoppage, how the crew communicates in a noisy environment) is fundamentally safer than a crew that figures those things out on the fly after the trucks are parked on the shoulder.

This section addresses the components of an effective pre-task planning process for high-exposure survey operations. The process described here is not tied to any specific form, checklist format, or regulatory framework. It is a set of principles that can be adapted to whatever documentation system a firm uses or that a solo surveyor applies informally before a field operation. The goal is not paperwork. The goal is deliberate thought applied to specific conditions before exposure begins.

### Site Assessment Before Mobilization

Effective pre-task planning begins with a site assessment that occurs before the crew is dispatched. For straightforward operations on familiar roads, this assessment may take ten minutes and rely primarily on available information (aerial imagery, roadway databases, prior project files, and local knowledge). For complex or unfamiliar sites, it may require a dedicated drive-through before the survey crew mobilizes. Either way, the surveyor should be able to answer a specific set of questions about the site before the crew arrives.

The first set of questions concerns the physical environment. What is the posted speed limit, and what is the realistic operating speed of traffic at the site? These are not always the same number. Roads where traffic routinely travels well above the posted limit require a higher level of protective response than the posted speed alone would suggest. What is the lane configuration? How many travel lanes are present, and in which directions? Is there a shoulder, and if so, how wide is it and what is its surface condition? Are there horizontal or vertical curves that limit sight distance in either direction? Is there adjacent land use that generates turning movements, driveway traffic, or pedestrian activity that complicates the exposure picture?

The second set of questions concerns traffic volume and composition. High-volume roads present a statistical exposure problem (the more vehicles that pass through the work area, the greater the probability that one of them will behave unpredictably). Roads with significant truck traffic present a physical exposure problem because large vehicles generate more turbulence, have longer stopping distances, and create more severe consequences in a struck-by event. Traffic composition data is available for most public roads through transportation agency databases, and for survey operations on high-volume facilities, reviewing that data before planning the traffic control approach is a reasonable professional standard.

The third set of questions concerns time of day and duration. What are the peak traffic hours for this facility, and does the planned operation overlap with them? How long will the crew be on site? An operation that takes two hours carries a different cumulative exposure than one that requires a full day. Is the work seasonal, and if so, are there visibility or surface condition factors associated with the planned season that affect the risk profile? Early morning operations in winter may involve frost on pavement, reduced visibility, and drivers who are not fully alert. Late afternoon operations in summer may involve sun glare from the west that blinds drivers approaching from that direction.

The fourth set of questions concerns the regulatory and permit environment. Does the work require a permit or encroachment authorization from a road authority? If so, what conditions does that permit impose on the operation? Some permits specify traffic control requirements, hours of operation, or minimum crew configurations. Those conditions represent a floor, not a ceiling. The surveyor may determine that site conditions warrant measures beyond what the permit requires, and that determination should be made based on the actual exposure assessment rather than defaulting to the permit minimum.

## Risk Assessment Framework

Once the site information is assembled, the surveyor needs a way to evaluate it systematically. A risk assessment framework provides that structure. The framework does not need to be complex. At its core, risk is a function of two variables: the likelihood that a hazardous event will occur, and the severity of the consequences if it does. A high-likelihood, high-severity combination demands the most aggressive protective response. A low-likelihood, low-severity combination may require only basic precautions. Most survey operations in roadway environments fall somewhere in between, and the value of the framework is that it forces a deliberate evaluation rather than a gut-level call.

Likelihood factors for roadway survey operations include traffic speed, traffic volume, sight distance, proximity of the work to the travel lane, duration of exposure, and the predictability of driver behavior at the specific location. A site near a school zone during dismissal hours has unpredictable driver behavior as a high-likelihood factor. A site on a rural interstate with no interchanges nearby has high speed as a dominant factor but relatively predictable traffic flow.

Severity factors include the speed of potential impact, the presence or absence of a physical barrier between the crew and traffic, the availability of an escape route if a vehicle enters the work space, and the medical response time for the location. A crew working on a bridge deck with no barrier and a 20-minute emergency medical services (EMS) response time faces a higher severity profile than a crew working on a suburban arterial with a concrete median barrier and a fire station two blocks away.

After evaluating both dimensions, the surveyor should be able to assign a general risk level to the operation. Not as a formal scoring exercise, but as a professional judgment that drives the protective response. A high-risk assessment should trigger a corresponding level of traffic control, PPE, crew configuration, and operational discipline. A moderate-risk assessment allows more flexibility but still requires a defined plan. A low-risk assessment does not mean no plan. It means the plan is appropriately scaled to the actual exposure.

## The Pre-Task Briefing

**Risk assessment that stays in the surveyor's head does not protect the crew.** The output of the pre-task planning process must be communicated to every person who will be in the field. The pre-task briefing is the mechanism for that communication, and it should occur before the crew deploys from the staging area, not after they arrive at the site and are already in proximity to traffic.

<u>An effective pre-task briefing covers several specific topics. It describes the work location and the nature of the exposure (what kind of road, what traffic conditions are expected, and what the primary hazards are for this specific operation). It assigns roles such as who is operating the instrument, who is holding the rod, who is managing the crew vehicle, and if flaggers are being used, who is coordinating with them. It describes the traffic control plan including what devices are being deployed, where they go, and in what sequence the setup will occur. It identifies the abort conditions (the specific circumstances under which the crew will stop work and withdraw from the site). And it establishes the communication protocol of how crew members will signal each other in an environment where verbal communication may not be reliable due to traffic noise.</u>

The abort condition discussion deserves particular emphasis. Many crews have a general understanding that they will leave if things get dangerous, but they have never defined what dangerous means in operational terms before arriving at the site. That ambiguity is a problem. When conditions are deteriorating and a crew member is trying to decide whether to call the work, the pressure to keep going is significant. Schedule pressure, the cost of remobilization, and the natural reluctance to be the person who called a stop all push against the decision to withdraw. **A pre-defined abort condition removes that ambiguity. If the crew agreed before leaving the staging area that a specific set of circumstances triggers a work stoppage, the crew member who recognizes those circumstances does not have to make a judgment call under pressure. The decision was already made.**

Abort conditions should be specific enough to be recognizable in the field. Examples of operationally useful abort conditions include a reduction in visibility below a defined threshold due to weather, the displacement or loss of traffic control devices that cannot be immediately replaced, a vehicle incursion into the work space, a crew member showing signs of heat stress or impairment, and the arrival of peak traffic conditions that were not anticipated in the pre-task assessment. The list should be calibrated to the specific hazards identified in the risk assessment for that operation.

## Traffic Control Planning as Part of Pre-Task Preparation

Traffic control planning is a component of pre-task preparation, not a separate activity. The surveyor should know before leaving the office what traffic control will be deployed, who will deploy it, what equipment is on the truck, and whether that equipment is adequate for the site. Arriving at a high-speed arterial with a handful of cones and no advance warning signs because the planning process did not include a traffic control assessment is a preventable failure.

The specifics of traffic control are addressed in detail in the following section. For pre-task planning purposes, the relevant questions are: does the traffic control plan match the exposure level identified in the risk assessment, does the crew have all of the equipment needed to execute that plan, and is there a contingency if conditions at the site differ from what was anticipated during office-based planning?

That last question (the contingency) is important because site conditions frequently differ from what aerial imagery and database information suggest. A shoulder that looks adequate from overhead may be occupied by accumulated debris, soft soil, or standing water when the crew arrives. A sight distance that appeared sufficient on a plan view may be compromised by a recently installed sign or vegetation that was not visible in the imagery. The pre-task plan should include a specific step at the beginning of field operations where the crew chief confirms that site conditions match the assumptions made during planning, and a defined response if they do not.

## Documentation and Accountability

Pre-task planning creates a record of professional judgment. When a firm uses a written pre-task checklist or job hazard analysis (JHA) form, that document serves as evidence that the surveyor evaluated the hazards before the crew was exposed to them. In the event of an incident, that documentation is relevant to both the legal and professional conduct dimensions of the aftermath. A firm that can demonstrate a consistent, documented pre-task planning process is in a fundamentally different position than one that cannot.

Documentation also serves a forward-looking function. A JHA completed for a recurring operation on a specific corridor becomes a baseline that can be reviewed and updated as conditions change. If the same road is surveyed multiple times over the course of a project, the pre-task documentation from earlier operations can be reviewed to identify whether conditions have changed and whether the protective measures deployed previously were adequate. That institutional memory is valuable, particularly for firms with multiple crew chiefs who may be rotating through the same project over time.

The discipline of pre-task planning, practiced consistently, also has a cultural effect on the crew. When the surveyor treats the planning process seriously (when the briefing is substantive rather than perfunctory, when abort conditions are defined rather than vague, when the traffic control plan is specific rather than improvised) the crew members receive a clear signal about the standard of care that is expected**. That signal accumulates over time into a crew culture where safety is treated as a professional obligation rather than an inconvenience.** That culture is the most durable form of protection a surveyor can build into a field operation, and it starts with how the work is planned before anyone gets in the truck.

## Section 7 — Temporary Traffic Control Principles for Survey Operations

Of all the protective measures available to a survey crew working in a roadway environment, temporary traffic control (TTC) is the most consequential. Personal protective equipment makes crew members more visible. Situational awareness keeps them alert. But TTC is the only measure that physically intervenes between the crew and the vehicles that represent the primary hazard. A well-designed and correctly deployed TTC setup reduces the probability that a vehicle will enter the work space in the first place. Everything else manages the consequences if one does. That distinction in function is why TTC deserves its own section and why the surveyor responsible for a field operation needs a working understanding of its principles, not just familiarity with the hardware.

This section does not attempt to replicate a traffic control design manual or serve as a substitute for formal training in that discipline. What it addresses is the conceptual framework that underlies effective TTC for survey operations which is the logic behind device placement, the zone structure that governs how a work area is organized, the common failure modes that compromise TTC effectiveness, and the judgment calls that arise when field conditions do not match the plan. Additionally, many government agencies have standard safety standards, such as sign placement, that should be followed (and reviewed and approved by the agency if required).

### The Zone Structure of a Temporary Traffic Control Setup

Effective TTC organizes the roadway around the work area into a sequence of zones, each serving a distinct function. Understanding those zones and their purposes is the foundation for making sound decisions about device placement and spacing.

**The advance warning zone is the first zone encountered by approaching traffic.** Its purpose is to alert drivers that conditions ahead differ from normal and that a change in behavior is required. Advance warning is typically provided through a series of signs placed at intervals upstream of the work area. The placement interval such as how far apart the signs are and how far the first sign is from the work area are a function of traffic speed. Higher speeds require greater advance warning distance because drivers need more time and distance to perceive the warning, process it, and adjust their speed and lane position before reaching the work area. On high-speed facilities, adequate advance warning distance may extend a quarter mile or more upstream of the actual crew location. On low-speed urban streets, the distance is shorter, but the principle is the same: drivers need time to respond before they are in the work space.

A common failure in survey TTC setups is insufficient advance warning distance. The crew places the first sign close to the work area because placing it further upstream requires more walking, or because the available sign inventory does not include enough devices to achieve proper spacing, or simply because no one calculated the required distance before the setup began. The result is that drivers encounter the work zone with inadequate reaction time, which is one of the primary conditions that precedes struck-by events. Calculating the required advance warning distance before arriving at the site (and confirming that the available equipment is sufficient to achieve it) is a basic pre-task planning step that directly affects crew safety.

The transition zone follows the advance warning zone and is the area where traffic is redirected around the work space. On roads where a lane must be closed or traffic must shift laterally, the transition zone is where that shift occurs. Tapers (the angled line of devices that guides traffic from its normal path to the adjusted path) are the primary feature of the transition zone. Taper length is a function of lane width and traffic speed, and the geometry matters. A taper that is too short forces abrupt lateral movement that drivers may not execute safely at speed. A taper that is properly proportioned guides traffic smoothly and predictably around the work area. When the transition zone is compromised (devices are missing, displaced, or improperly spaced) the predictability of traffic movement through the area degrades, which increases the likelihood that a vehicle will track into the work space rather than around it.

The activity area is the zone where the survey crew is actually working. It is subdivided into a work space, which is the area occupied by personnel and equipment, and a buffer space, which is a distance of clear space between the work space and the nearest travel lane or channelizing device. Buffer space serves as a safety margin which is a physical gap that provides additional reaction distance for both the crew and any vehicle that tracks toward the work area. The size of the buffer space is influenced by traffic speed, the nature of the work, and the physical dimensions of the site. On high-speed facilities, the buffer should be as large as the geometry of the site allows. Minimizing the buffer to make the work more convenient is a trade of safety margin for operational efficiency that is rarely justified.

The termination zone is the area downstream of the work space where traffic returns to normal operations. On a single-lane closure, this is where the closed lane reopens and traffic merges back to normal lane positions. The termination zone is frequently the least carefully constructed part of a TTC setup, because it is farthest from where the crew is working and receives less attention during setup. But a poorly constructed termination zone can create confusion for drivers (particularly those approaching from the opposite direction on a two-lane road) and can result in vehicles entering the work area from an unexpected direction.

## Flagging Operations in Survey Contexts

When a survey operation requires one-way alternating traffic control on a two-lane road, flaggers are typically the mechanism for managing traffic movement through the work area. Flagging is a task-specific skill that requires dedicated training and, in many jurisdictions, certification. The surveyor responsible for the operation is not expected to be the flagger's trainer, but is expected to understand what a properly conducted flagging operation looks like, what it requires, and when it is not adequate for the conditions present.

A flagging operation requires at minimum one qualified flagger at each end of the work zone on a two-lane road, with reliable communication between them. That communication may be by radio, by hand signal if sight lines permit, or by phone. The critical requirement is that both flaggers are in continuous contact and that traffic is not released from both ends simultaneously. A flagging operation where the flaggers cannot reliably communicate with each other is not a functioning flagging operation. Simply put it is two people holding signs at opposite ends of a road with no coordinated control of traffic movement between them. That distinction matters because the failure mode of a non-communicating flagging operation is a head-on conflict within the work zone, which is a high-severity event.

The surveyor should also recognize that flaggers require active supervision during the operation. A flagger who has been standing in position for three hours in high heat is not performing at the same level as one who is fresh. Fatigue affects attention, reaction time, and the consistency of signal timing. Scheduling flagger rest breaks, rotating positions where the crew configuration allows it, and monitoring flagger performance throughout the operation are crew leadership responsibilities that fall to the person in charge.

There are also conditions under which a standard flagging operation is not adequate for the exposure level present. On roads with high traffic volume, limited sight distance, or speeds above certain thresholds, manually operated flagging may not provide sufficient reaction time for drivers approaching the work zone. In those conditions, more robust traffic control measures (including pilot vehicles, automated flagger assistance devices, or full lane closures with law enforcement present) may be warranted. Recognizing when standard flagging is not enough is a professional judgment call that the surveyor responsible for the operation must be prepared to make.

## Traffic Control Device Selection and Condition

The effectiveness of a TTC setup is only as good as the devices used to construct it. Device selection and condition are practical concerns that are easy to overlook in the routine of daily field operations but have direct consequences for setup effectiveness.

Channelizing devices (cones, drums, tubes, and barriers) vary in their physical presence, visibility, and resistance to displacement. Cones are the most commonly used device in survey TTC setups because they are lightweight, portable, and easy to deploy. They are also the most easily displaced by vehicle turbulence, wind, and inadvertent contact. A cone that has been knocked over or pushed out of position is no longer performing its channelizing function, which means the taper or buffer it was part of has been compromised. Periodic inspection of the device layout during the operation (not just at setup) is a necessary maintenance step that crews frequently skip once the initial setup is complete.

Retro-reflectivity is a device property that matters significantly in low-light and nighttime operations and that degrades with age and exposure. A cone that was adequately retroreflective when new may no longer meet that standard after two seasons of use and sun exposure. Surveying firms that conduct regular roadway work should establish a replacement schedule for traffic control devices based on condition rather than simply replacing them when they are physically damaged. A device that looks structurally intact but has lost its retroreflective properties is a safety liability in low-light conditions.

Sign condition and legibility are equally important. Advance warning signs that are faded, damaged, or mounted at incorrect angles do not communicate their message effectively to approaching drivers. Signs should be inspected before each use and removed from service when their condition compromises legibility. The investment in maintaining a serviceable sign inventory is modest compared to the consequences of operating with inadequate advance warning.

## Adapting TTC to Non-Standard Site Conditions

Survey sites frequently present conditions that do not conform neatly to standard TTC layouts. Curves, intersections, driveways, variable shoulder widths, and irregular terrain all require the surveyor to adapt the standard zone structure to the specific geometry of the site. That adaptation process requires understanding the purpose behind each zone (not just the standard layout) because adapting effectively requires knowing what function must be preserved even when the standard geometry cannot be replicated.

On a curved road where sight distance is limited, the advance warning zone must account for the reduced preview distance available to approaching drivers. If a standard advance warning distance of 500 feet is not achievable because a curve brings the work area into view at only 200 feet, the response is not to accept 200 feet of warning distance. The response is to either extend warning devices further upstream to provide adequate distance, adjust the crew position to a location with better sight distance, or determine that the site cannot be safely occupied without more robust traffic control than a standard sign-and-cone setup provides.

At intersections, the multi-directional nature of traffic movement requires advance warning on multiple approaches and careful attention to which approach angles create the most significant exposure for the crew. A crew working in the center of an intersection is exposed to traffic from all directions simultaneously, which means the TTC setup must address all of those directions rather than just the primary road.

The consistent thread through all of these adaptive situations is that the surveyor must evaluate each site on its own terms, starting from first principles about what the TTC is supposed to accomplish, rather than defaulting to a standard layout that may not fit the conditions. That evaluative capacity is what distinguishes a surveyor who understands TTC from one who simply knows how to set up cones.

## Knowing When the Plan Is Not Working

A TTC setup that was adequate at the beginning of an operation may become inadequate as conditions change. Recognizing when the plan is no longer working, and responding to that recognition decisively, is one of the most important field judgment calls a surveyor makes.

Indicators that a TTC setup is failing include repeated vehicle incursions into the buffer or work space, consistent driver non-compliance with channelizing devices, displacement of advance warning signs or channelizing devices that cannot be promptly corrected, and changes in traffic volume or composition that exceed what the setup was designed to accommodate. Any of these conditions should trigger a reassessment of whether the current setup is adequate, whether it can be corrected in place, or whether the crew needs to withdraw and replan before continuing.

The instinct to keep working through a degrading TTC situation is understandable because stopping costs time and creates schedule pressure. But a TTC setup that is no longer functioning as designed is no longer providing the protection it was intended to provide. Working in that condition is working without the margin of safety that was built into the original plan, and that margin existed for a reason. The professional obligation is to restore adequate protection before continuing, not to accept the degraded condition because withdrawal is inconvenient.

# Section 8 — Personal Protective Equipment and Situational Awareness

Personal protective equipment and situational awareness are treated together in this section because they represent complementary layers of the same protective strategy. PPE reduces the consequences of a hazardous event by making crew members more visible and, in limited respects, more physically protected. Situational awareness reduces the likelihood of a hazardous event by keeping crew members cognitively engaged with the environment around them. Neither layer is sufficient on its own. A crew that wears all the right gear but stops paying attention to traffic is relying entirely on drivers to avoid them. A crew that is highly alert but wearing inadequate PPE has reduced the window available for drivers to recognize and respond to their presence. The two layers work together, and training crews to understand that relationship is as important as training them on the specific requirements of each.

## Personal Protective Equipment for Roadway Survey Operations

The most universally applicable PPE requirement for roadway survey work is high-visibility apparel. The purpose of high-visibility clothing is straightforward: it makes the wearer conspicuous to approaching drivers at greater distances than ordinary work clothing would allow, which increases the reaction time available to the driver and reduces the probability of a struck-by event. That purpose seems obvious, but its implications are frequently not well understood at the crew level, which is why training on the subject matters.

High-visibility apparel is classified by performance class, with higher classes providing greater visibility through larger areas of fluorescent and retroreflective material. The appropriate class for a given operation depends primarily on traffic speed and the complexity of the visual background against which the worker will be seen. On high-speed roadways where workers are in or adjacent to the travel lane, the highest performance class is the appropriate standard. On lower-speed roads with lower traffic volumes, a lower class may be adequate. The surveyor responsible for the operation should establish the minimum apparel standard for the crew based on the exposure assessment conducted during pre-task planning, and that standard should be treated as non-negotiable for the duration of the operation. It's worth noting that the cost difference between classes of visibility is typically minimal compared to the risks. In general, always use the highest available source of PPE for the task at hand.

One of the more persistent PPE failures in field survey operations is the partial compliance problem. A crew member wears the required vest at the start of the shift but removes it during a break and does not put it back on. Another crew member leaves the vest in the truck while retrieving equipment because the walk from the vehicle to the work area seems brief. A third crew member wears a vest that meets the performance class requirement but has accumulated enough dirt and wear that its retroreflective strips no longer function effectively. All three of these situations represent a gap between the PPE standard that was established and the PPE that is actually being worn. Closing that gap requires active supervision, not just a policy statement at the beginning of the day.

Training crews on the why behind high-visibility requirements (not just the what) is one of the most effective ways to improve compliance. A crew member who understands that a retroreflective strip on a degraded vest loses much of its effective range under headlight illumination, and who can translate that into the reaction time math described in Section 5, is more likely to treat the apparel requirement seriously than one who has simply been told to wear the vest because it is required. The professional obligation of the surveyor running the crew includes ensuring that crew members have that level of understanding, not just that they own the equipment.

Footwear is a PPE consideration that receives less attention than high-visibility apparel but is directly relevant to the slip, trip, and fall hazard profile described in Section 5. Roadway surfaces present a range of footing conditions such as smooth worn pavement, painted markings that become slick when wet, gravel shoulders, utility cuts backfilled with loose material, and bridge deck gratings or expansion joints that can catch a boot. Footwear appropriate for roadway survey work should provide ankle support, slip-resistant soles, and sufficient sole thickness to provide some protection against sharp objects embedded in pavement surfaces. Open-toed footwear, athletic shoes, and smooth-soled boots are not appropriate for roadway survey environments regardless of how brief the field exposure is expected to be.

Head protection in the roadway survey environment is situationally dependent. On work sites that are also active construction zones, hard hat requirements are typically imposed by the construction site safety plan and are not optional. On standalone survey operations in roadway environments, the head protection decision is driven by the specific hazards present. Overhead hazards (low-clearance structures, equipment operating above the crew, materials being handled at elevation) warrant head protection regardless of whether a construction site requirement applies. The absence of a formal requirement does not eliminate the hazard, and the surveyor responsible for the operation should evaluate overhead exposure as part of the pre-task assessment.

Hand protection is relevant when crew members are handling metal stakes, pin flags with wire stems, traffic control devices, or equipment that has been sitting in direct sun and has reached surface temperatures that can cause contact burns. Cut-resistant gloves are appropriate when vegetation clearing is part of the field operation. The point is not that gloves are always required. The point is that hand protection should be part of the equipment assessment rather than an afterthought.

Eye and ear protection are appropriate in specific conditions. Crews working near highway milling or paving operations, or in areas where debris is being generated by traffic or adjacent construction, should have eye protection available and should use it when conditions warrant. Hearing protection is relevant during extended operations in high-noise environments, though the crew chief must balance hearing protection use against the communication requirements of the operation. A crew member wearing hearing protection who cannot hear a warning from another crew member has traded one risk for another. Communication protocol should account for hearing protection use when it is required.

## Building a PPE-Compliant Crew Culture

Equipment requirements only protect the crew if they are consistently followed in the field, away from the office, and often without direct supervision from the surveyor of record. That reality places a premium on crew culture (the shared set of expectations and norms that govern how the crew behaves when no one is watching). Building a PPE-compliant crew culture is a training and leadership function, not an administrative one.

The most effective approach is to establish PPE standards as a non-negotiable baseline from the first day a crew member is in the field, and to maintain that standard consistently regardless of how routine or brief the operation appears. When exceptions are made (when a crew chief allows a crew member to skip the vest for a two-minute task near the road because it seems unnecessary) those exceptions communicate that the standard is negotiable. Negotiable standards erode quickly in field environments because there is always a reason why a particular situation seems like it should be an exception.

Crew chiefs play a central role in this process. The crew chief is the person on the ground who sets the behavioral standard by their own example and by their response when crew members deviate from it. A crew chief who wears the vest consistently, who corrects non-compliance immediately and without ambiguity, and who treats PPE requirements as a professional expectation rather than an imposition builds a different crew culture than one who is inconsistent about their own compliance and tolerant of deviation in others. Investing in the crew chief's understanding of why these standards exist (not just what they are) is one of the highest-return safety investments a surveying firm can make.

Peer accountability is another mechanism worth developing deliberately. In a crew where safety standards are well established, crew members look out for each other as a matter of course. A rod person who reminds the instrument operator to put the vest back on after a break is functioning as a safety resource, not just a subordinate performing a task. That kind of lateral accountability does not develop automatically. It emerges from a crew culture where safety is treated as a shared responsibility rather than something managed only from the top down. The surveyor responsible for the crew can cultivate that culture through the way safety topics are addressed in pre-task briefings, through the way non-compliance is handled when it occurs, and through the way close calls are discussed rather than dismissed.

## Situational Awareness in High-Exposure Environments

Situational awareness (the continuous, active process of monitoring the environment, interpreting what is observed, and anticipating how conditions may change) is a cognitive skill that can be developed and trained, not simply a personality trait that some crew members have and others do not. Understanding it as a trainable skill is the starting point for building it deliberately into crew operations.

In the roadway survey context, situational awareness has three practical components. The first is perception — actually seeing and hearing what is happening in the environment. The second is comprehension — understanding what the observed information means in terms of crew exposure. The third is projection — anticipating how the situation is likely to develop and what that will mean for the crew's position and activity in the near future. A crew member who sees a vehicle approaching but does not register that it is moving faster than the flow of traffic, and does not anticipate that it may not slow for the work zone, has perception without comprehension or projection. That gap is where incidents occur.

Training crews on situational awareness starts with making the concept explicit. Many crew members have never been given a framework for thinking about how they monitor their environment. They rely on instinct, which is inconsistent and degrades under fatigue and distraction. Giving crew members a simple, explicit model (see what is there, understand what it means, anticipate what comes next) and practicing applying that model in field environments builds a more reliable and consistent monitoring habit than relying on instinct alone.

Practical situational awareness habits that can be trained and reinforced include establishing a consistent scan pattern when working near traffic, designating a crew member as a dedicated traffic monitor during high-exposure tasks, defining verbal and non-verbal warning signals before the operation begins, and establishing a standing protocol for what every crew member does when a warning signal is given. That last element (the response protocol) is frequently omitted from crew training on situational awareness, which is a significant gap. A crew member who hears a warning signal but has no pre-established response behavior loses critical seconds deciding what to do. A crew member who has been trained to immediately move to a designated safe position in response to a specific signal does not have to make that decision under pressure.

The concept of eyes-up discipline is worth developing explicitly with crews. Eyes-up discipline is the practice of periodically breaking away from the immediate task (looking up from the instrument, the data collector, the field notes) to actively scan the traffic environment before returning to the task. The frequency of those breaks should be calibrated to the exposure level of the operation. On a high-speed arterial with live traffic in an adjacent lane, eyes-up intervals should be short and frequent. On a low-volume rural road with adequate sight distance and a wide shoulder, longer task intervals are appropriate. Training crew members to self-regulate their eyes-up frequency based on the exposure level, rather than applying the same interval regardless of conditions, builds a more adaptive and effective monitoring habit.

Distraction management is closely related to situational awareness and equally trainable. The structural distraction problem inherent in survey work (the fact that the tasks require looking away from traffic) was addressed in Section 5. The training response to that problem is to build awareness of distraction into the pre-task briefing and to establish specific task sequencing that minimizes exposure during the moments of highest inattention. If the instrument operator must keep their eye to the eyepiece for an extended period during a critical measurement, that is the moment when another crew member should be in an active monitoring role. Assigning monitoring responsibilities explicitly, rather than assuming that everyone is watching traffic simultaneously while also doing their jobs, is a crew coordination decision that belongs in the pre-task plan.

## Recognizing and Responding to Changing Conditions

Situational awareness is not just about monitoring traffic. It also includes monitoring the overall condition of the operation such as the TTC setup, the condition of crew members, the weather, and any other factor that affects the exposure level. A crew chief who is actively aware of the operation as a system, rather than focused exclusively on the survey tasks being performed, is in a position to recognize when something has changed and respond before that change produces a hazardous condition.

Specific conditions that warrant immediate attention and potential operational adjustment include a visible change in driver behavior (vehicles slowing down and gawking, aggressive passing, or ignoring channelizing devices) which may indicate that the TTC setup is not communicating effectively. A crew member who appears fatigued, disoriented, or physically distressed warrants immediate attention because impaired crew members increase exposure for the entire crew. Weather changes that reduce visibility or alter road surface conditions may require TTC adjustments or work stoppage. Equipment failures (a radio that stops working in the middle of a flagging operation, a vehicle that cannot be repositioned) require immediate assessment of whether the operation can continue safely without the failed component.

The ability to recognize these conditions and respond to them decisively is a function of active situational awareness maintained throughout the operation, not just at setup. It is also a function of the pre-task planning process such as a crew chief who defined abort conditions before the operation began recognizes the indicators of those conditions more quickly than one who is making the assessment for the first time under field pressure. PPE and situational awareness, like every other element of this course, connect back to the planning process. The better the plan, the more effectively every protective layer performs in the field.

## Section 9 — Emergency Response and Crew Leadership in High-Exposure Environments

No amount of planning eliminates risk entirely. Survey crews that work in roadway environments long enough will eventually encounter a situation that escalates beyond what the pre-task plan anticipated such as a vehicle enters the work space, a crew member is struck or injured, a medical emergency occurs in the field, or conditions deteriorate so rapidly that an orderly withdrawal becomes difficult. The question is not whether those situations will arise over the course of a career. The question is whether the crew is prepared to respond to them effectively when they do.

Emergency response in the roadway survey context is not the same as general first aid or workplace emergency planning. It has specific characteristics that distinguish it from emergencies in fixed workplaces. The location is often remote from emergency services. The environment is dynamic. For example, traffic continues to move during and after an incident unless active steps are taken to stop it. The crew is small, which means the personnel available to manage the emergency are the same personnel who may be directly affected by it. And the actions taken in the first several minutes after an incident can significantly affect both the outcome for any injured person and the safety of the remaining crew members.

This section addresses emergency response principles and crew leadership in the context of those specific characteristics. It also addresses the broader leadership responsibilities of the surveyor who runs a field crew including the professional obligations that extend beyond technical competence into the management of people, decisions, and risk in a high-exposure environment.

### Immediate Response to a Roadway Incident

**When an incident occurs in or near a survey work zone, the immediate priorities are life safety, scene stabilization, and notification — *in that order*.** The temptation in a chaotic situation is to focus on the most visually urgent element, which is often the injured person. But in a roadway environment, failing to address scene stabilization can result in secondary incidents that injure additional crew members or complicate access for emergency responders. The first minutes after an incident require the crew to manage multiple simultaneous priorities, which is why pre-established response protocols are essential.

Life safety in the immediate aftermath of a roadway incident means accounting for every crew member and moving any person who is in immediate danger of being struck by traffic to a protected position. If a crew member has been struck and is lying in or near the travel lane, the first priority is to protect that person from further vehicle contact either by moving them if it is safe to do so without aggravating an injury, or by stopping traffic upstream of their location. The decision to move an injured person is a difficult one because movement can worsen certain injuries, particularly spinal injuries. The countervailing consideration in a live traffic environment is that leaving an injured person in an exposed position while waiting for emergency medical services (EMS) may result in additional trauma from a subsequent vehicle contact. That judgment call must be made based on the specific conditions present, and crew members should be trained in advance on the factors that inform it.

Scene stabilization means taking active steps to prevent additional vehicles from entering the area where the incident occurred. If the existing traffic control setup is still in place and functioning, it may provide adequate protection. If the incident has disrupted the traffic control setup (a vehicle that entered the work zone may have displaced channelizing devices, for example) restoring or augmenting that protection is an immediate priority. In situations where the available traffic control is clearly inadequate to protect the scene, a crew member should be positioned upstream to warn approaching traffic, using whatever signaling means are available, until law enforcement or emergency responders arrive and assume scene management.

Notification means contacting emergency services as quickly as possible after the immediate life safety and scene stabilization steps have been addressed. The call to emergency services should include the location of the incident, stated as precisely as possible (road name, nearest intersection or milepost, direction of travel, and any landmarks that will help responders locate the scene). It should include the nature of the incident and the number of people injured. It should include any access considerations if the work zone setup affects how emergency vehicles can approach the scene, that information needs to be communicated to the dispatcher so that responders are aware of it before they arrive.

Pre-planning the notification process is one of the most valuable and most frequently overlooked components of emergency response preparation. Before the crew mobilizes, the crew chief should confirm the address or milepost of the work location and have that information immediately accessible. In rural or unfamiliar areas, GPS coordinates are a useful supplement to address information because they can be communicated quickly and precisely to a dispatcher. The crew chief should also confirm that at least one crew member has a charged phone at all times during the operation, and should identify the nearest hospital or trauma center as part of the site assessment for high-exposure operations in remote locations.

## Crew Accountability After an Incident

One of the operational realities of a small field crew is that an incident may incapacitate the person who would normally be in charge. The crew chief may be the person who is injured. In that situation, another crew member must be able to step into the response role immediately, without hesitation and without having to figure out what to do from scratch. That capability does not develop automatically. It requires deliberate preparation.

Every crew member should know, before the operation begins, what the emergency response protocol is and what their role in it would be if the crew chief were unable to direct the response. That includes knowing the work location precisely enough to communicate it to emergency services, knowing where the first aid kit is and what it contains, knowing who to contact within the firm after an incident occurs, and knowing what information will need to be documented as soon as the immediate emergency is under control. Treating emergency response preparation as a crew-wide responsibility rather than solely a crew chief responsibility is a leadership decision that significantly improves the crew's resilience when an incident occurs.

Crew accountability (knowing where every person is at all times during the operation) is both a routine operational discipline and a critical emergency response tool. In the immediate aftermath of an incident, the first question that must be answered is whether everyone on the crew is accounted for. If a crew member is missing, the response priority shifts immediately. A crew that has never practiced accountability as a routine discipline will have difficulty executing it effectively under the stress of an emergency. Crews that practice regular position checks as a normal part of field operations have that discipline already built in.

## Post-Incident Responsibilities

The period immediately following an emergency is operationally demanding in ways that extend beyond the incident itself. Once emergency responders have assumed control of the scene and injured personnel are receiving care, the crew chief or the person managing the response has a set of professional and organizational responsibilities that must be addressed.

Documentation should begin as soon as the immediate emergency is resolved and it is safe to do so. The documentation should capture the time and nature of the incident, the conditions present at the time, the traffic control configuration that was in place, the actions taken by crew members in response, and the sequence of notifications made. This documentation serves multiple purposes (it supports any insurance or workers' compensation process, it provides a factual record for any regulatory or legal inquiry, and it creates the information base needed for the firm's internal incident review). Memories of chaotic events degrade quickly, and details that seem vivid immediately after an incident become unclear within hours. Beginning documentation promptly, while details are fresh, is a professional obligation.

Notification of firm leadership and, where required, regulatory authorities should follow promptly. Most jurisdictions impose notification requirements for workplace incidents that result in hospitalization or fatality, and those requirements have defined timelines. The surveyor of record for the project should be aware of those requirements in advance and should have the notification contacts and procedures accessible without having to research them after an incident has occurred.

The incident review process that follows is not primarily a blame-assignment exercise. Its purpose is to understand what happened, why it happened, and what changes to planning, equipment, or operational practice would reduce the likelihood of recurrence. An incident review that focuses on identifying the human error committed by the crew member most directly involved in the incident, without examining the systemic factors (the planning process, the traffic control setup, the supervision, the crew training) that created the conditions for that error, is an incomplete review. The most useful incident reviews examine the full chain of decisions and conditions that led to the outcome and identify the earliest point in that chain where a different decision would have changed the result.

## Crew Leadership as a Safety Function

Emergency response, at bottom, is a leadership discussion as much as a technical one. Pre-planning, crew training, accountability protocols, and post-incident documentation are all crew leadership functions, and so are the pre-task planning process, the traffic control setup, the PPE standard enforcement, and the situational awareness culture described in earlier sections. The technical knowledge required to run a safe survey operation is learnable and not particularly complex; the harder and more consequential piece is the leadership discipline to apply that knowledge consistently, make difficult calls when conditions warrant them, and maintain a crew culture where safety is a professional standard rather than a compliance exercise.

The surveyor who runs a field crew occupies a position of genuine authority and genuine responsibility. Crew members look to that person for guidance on how the work is done, what standards apply, and how the crew should respond when something goes wrong. That authority and responsibility are not limited to the technical quality of the survey product. They extend to the conditions under which the work is performed and the safety of the people performing it.

One of the more difficult leadership challenges in high-exposure survey work is managing the pressure to continue operations when conditions suggest the crew should stop. That pressure comes from multiple directions such asclient schedule demands, project budget constraints, the desire to avoid the friction of a work stoppage, and the general professional culture in surveying that places high value on getting the job done regardless of conditions. None of those pressures are inherently unreasonable, but all of them can become drivers of unsafe decisions when they are allowed to override a clear-eyed assessment of crew exposure.

The right response to that pressure is a framework for evaluating it against the actual risk present in the field, and a willingness to communicate that evaluation clearly to whoever is applying it — not ignoring the pressure or pretending it isn't there. A surveyor who can articulate specifically why a work stoppage is warranted (referencing the conditions present, the protective measures available, and the gap between the two) is in a fundamentally stronger position than one who simply says conditions do not feel right. The risk assessment framework, the pre-task planning process, and the abort conditions defined before the operation began all contribute to that articulateness. They give the surveyor the professional vocabulary to defend a safety decision in terms that clients, supervisors, and project managers can understand and that are difficult to dismiss.

## Developing Leadership Capacity in the Field

Leadership capacity in high-exposure survey environments does not develop solely through experience. It develops through deliberate preparation, structured feedback, and a firm culture that treats safety leadership as a professional competency worth investing in. Firms that rely on experience alone to develop crew leadership capability produce crew chiefs who are competent at the tasks they have encountered before and underprepared for the ones they have not.

Deliberate preparation means giving crew chiefs explicit training on risk assessment, pre-task planning, traffic control principles, and emergency response; not just field surveying skills. It means providing them with the frameworks and vocabulary described throughout this course and giving them opportunities to apply those frameworks in supervised field conditions before they are doing so independently.

Structured feedback means reviewing field operations systematically; not just after incidents, but as a routine management practice. A crew chief who receives feedback on the quality of their pre-task planning, the effectiveness of their TTC setup, and the consistency of their PPE enforcement is developing leadership skills in those areas. A crew chief who receives feedback only on the technical accuracy of the survey product is not.

Firm culture means that the organizational environment in which crew chiefs operate either supports or undermines the safety leadership behaviors described in this course. A firm where safety decisions are second-guessed by project managers, where schedule pressure routinely overrides field judgment, and where incidents are addressed through blame rather than systemic review is a firm where safety leadership is structurally difficult regardless of the individual capability of the crew chief. Building the organizational conditions that support strong safety leadership is an obligation of firm ownership and management, not just of the field crew.

The surveyor who completes this course and returns to field operations with a clearer framework for planning, a better understanding of TTC principles, a stronger PPE standard, and a more deliberate approach to crew leadership is better positioned to protect the people under their charge (which is the standard licensed surveyors in high-exposure environments should hold themselves to).

## Section 10 — Closing Summary

Surveying in high-exposure areas is one of the most physically demanding and inherently hazardous activities that licensed surveyors perform. The roadway environment is not forgiving of lapses in judgment, gaps in preparation, or breakdowns in crew discipline. The consequences of those lapses are immediate and often severe in ways that most other professional errors are not. A calculation mistake can be corrected. A boundary dispute can be resolved. A crew member struck by a vehicle at highway speed cannot be uninjured.

The central argument of this course is that the gap between a safe field operation and an unsafe one is almost always a decision — usually a series of small decisions made before and during the operation that collectively determine whether the crew is adequately protected or whether they are relying on favorable circumstances to get through the day. That framing places responsibility squarely where it belongs: with the surveyor who plans and leads the operation.

The five main sections addressed that judgment in sequence. The course opened by examining how surveyors actually get hurt such as the specific mechanisms, the environment types that carry the highest risk, and the behavioral patterns that appear consistently in incident causation. That foundation matters because planning decisions are only as good as the understanding of what is being planned against. It then moved into pre-task planning, where a systematic site assessment, a structured risk evaluation, a substantive crew briefing, and pre-defined abort conditions were examined as the core components of a defensible and effective planning process.

Temporary traffic control was addressed as the most consequential single protective measure available to survey crews. The emphasis was on understanding the purpose behind each zone and each device type, because that understanding is what allows effective adaptation when standard layouts do not fit the conditions present. Personal protective equipment and situational awareness followed as complementary layers — PPE reducing the consequences of an event by improving visibility, situational awareness reducing the likelihood of an event by keeping crews cognitively engaged with their environment. Both were framed as training and leadership challenges as much as equipment and behavior requirements. The course closed with emergency response and crew leadership, treating them as inseparable topics and examining the leadership capacity that determines whether the technical knowledge in the preceding sections is actually applied in the field.

Three themes run through every section and are worth restating. Preparation is the primary protective measure (everything else performs better when it supports a well-planned operation. Consistency matters more than intensity) a crew that applies disciplined safety practice across every operation is safer than one that applies it selectively. And leadership is the mechanism by which knowledge becomes practice — the surveyor who understands this material but does not translate it into crew training, planning discipline, and consistent standard enforcement has not improved crew safety.

Licensed surveyors who work in high-exposure environments carry a professional obligation that extends beyond the technical accuracy of their work product. That obligation encompasses the safety of the people performing the work, the adequacy of the protective measures applied, and the leadership discipline to maintain standards when conditions make it inconvenient to do so.

## Section 11 — Review Questions

The following questions are designed to assess comprehension of the course material. Each question has four answer choices. Please refer the website to submit answers.

1. Which of the following best describes the term exposure as it is used in the context of roadway survey safety?

    A. The total number of hours a crew member spends on a job site in a given week

    B. The degree to which a person or crew is positioned where a hazardous event could cause injury or death

    C. The percentage of a survey project that occurs within the right of way

    D. The number of vehicles that pass through a work zone during a shift

2. A survey crew is preparing to work on a rural two-lane road with a posted speed of 55 miles per hour, limited shoulder width, and several horizontal curves that restrict sight distance. Which of the following represents the most significant primary risk factor for this operation?

    A. The likelihood of equipment theft from the survey vehicle

    B. The potential for instrument error caused by heat shimmer

    C. Inadequate driver reaction time due to restricted sight distance and high operating speed

    D. The difficulty of obtaining a right of way encroachment permit for rural roads

3. Which of the following is the most accurate description of normalization of deviance in the survey field context?

    A. The process by which new crew members learn safe habits from experienced crew chiefs

    B. The gradual perception that a repeated risk is acceptable because it has not produced a negative outcome

    C. The tendency for traffic volumes to increase predictably during morning and evening peak hours

    D. The adjustment of safety standards to match the requirements of a specific regulatory jurisdiction

4. A pre-task briefing conducted before a high-exposure survey operation should include which of the following elements?

A. A review of the project boundary description and deed research

B. Assignment of roles, traffic control plan details, communication protocols, and pre-defined abort conditions

C. A summary of the client contract terms and billing schedule

D. Confirmation that all crew members hold a current flagger certification

5. In the zone structure of a temporary traffic control setup, what is the primary purpose of the advance warning zone?

A. To provide a buffer of clear space between the work space and the nearest travel lane

B. To channel traffic from its normal path around the work area through a series of devices

C. To alert drivers that conditions ahead differ from normal and that a change in behavior is required

D. To mark the downstream end of the work zone where traffic returns to normal operations

6. A survey crew is conducting a flagging operation on a two-lane road and discovers that the radios being used for flagger communication have lost their charge. Which of the following is the most appropriate response?

A. Continue the operation using hand signals between flaggers if sight lines between the two positions are clear and unobstructed

B. Continue the operation and instruct one flagger to release traffic at timed intervals without coordinating with the other end

C. Cease the flagging operation and withdraw the crew from the site until reliable communication is restored or an alternative is established

D. Reduce the length of the one-way traffic queue to compensate for the absence of radio communication

7. Which of the following best explains why high-visibility apparel requirements should be established based on the exposure assessment for a specific operation rather than applied uniformly at the lowest acceptable performance class?

A. Higher performance class garments are required by federal regulation on all public roadways regardless of traffic speed

B. Apparel performance class affects the distance at which a worker is visible to approaching drivers, which directly relates to available driver reaction time

C. Lower performance class garments are only appropriate for operations that occur entirely off the traveled way

D. Uniform application of the lowest class simplifies crew equipment management and reduces procurement costs

8. Which of the following describes the correct order of immediate priorities following a struck-by incident involving a survey crew member in an active travel lane?

A. Notification of firm leadership, documentation of the incident, scene photography, and contact with emergency services

B. Life safety of the injured crew member and remaining crew, scene stabilization to prevent secondary incidents, and notification of emergency services

C. Withdrawal of all remaining crew members from the site, followed by notification of emergency services from a safe location

D. Contact with the project client, notification of emergency services, and documentation of traffic control device positions

9. Which of the following most accurately describes the role of pre-defined abort conditions in a high-exposure survey operation?

A. They establish the minimum traffic control configuration required to satisfy permit conditions for the operation

B. They document the crew chief's qualifications to make independent safety decisions in the field

C. They remove the ambiguity from the decision to stop work by defining in advance the specific conditions that require withdrawal

D. They provide a legal defense for the surveyor of record in the event of a regulatory inquiry following an incident

10. A crew chief who consistently enforces PPE standards by personal example, corrects non-compliance immediately, and addresses safety topics substantively in every pre-task briefing is primarily performing which of the following functions?

A. Satisfying the minimum training documentation requirements imposed by the firm's insurance carrier

B. Building a crew culture where safety is treated as a professional standard rather than a compliance exercise

C. Demonstrating technical proficiency in traffic control device placement and maintenance

D. Fulfilling the flagger supervision requirements associated with a lane closure permit

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