



Line of Sight (LoS)

Evaluation and Validation



General

The presence, or absence, of Line of Sight (LoS) is an important aspect of combat and combat training and, therefore, critical in the design of a live fire training range. Long distances, natural terrain, structures, plus firing positions and targets can all combine to block the view downrange. The designer must perform a graphical and/or numerical line-of-sight analysis during the design process to ensure that all firing positions, targets, limit markers, lane markers, etc. are properly sited and visible from the required location(s). LoS analysis may also be required from the control tower and camera locations to targets, firing positions, maneuver areas, etc. The computer-based analysis must begin with an accurate terrain model. Topographic surveys for the design of a range require sufficient accuracy to produce 0.5-meter (1 foot) contour intervals. The individual range sections in the RDG contain specific information on the LoS requirements for each particular range. In addition, on mounted maneuver ranges, the designer must coordinate with the range training and functional support personnel at the installation, ACOM, and TCM Ranges to determine the required training engagements and develop the target engagement capability matrix and subsequent LoS requirements.

The RTLTP MCX at the Huntsville Center reviews the required LoS as part of the design review process. For the larger maneuver ranges, the MCX uses a computer tool to analyze the LoS at designated milestones during the design; generally, the 35% and 95% design stages. The designer must provide fully modeled data, to include survey data, proposed trails, proposed target berms, proposed downrange power centers, target engagement capability matrix, and proposed firing and target positions in the format defined below for the evaluation. The MCX processes the data through the LoS analysis tool to determine/verify that the proposed range meets training table requirements. For small arms qualification ranges, the MCX may only verify that the designer has performed the required LoS analysis. The designer must provide profiles showing the required LoS. The stakeholders will evaluate and validate that the range provides the required LoS. None of these reviews absolves the designer from the responsibility of providing required line-of-sight when designing the range.

The angle of fire (AoF) is an important piece of information that the LoS calculates. The AoF affects the berms design and protection of the target equipment. Refer to the individual targetry emplacement sections in the RDG for detailed requirements/limits for angle of fire.

The other element of target visibility, (i.e. the target lifters ability to present 100% of the target silhouette above the berm), is beyond the scope of the RDG and not addressed in this section.

Line of Sight tools also perform beaten zone analyses. The beaten zone is the areas behind targets where rounds regularly hit. The repeated impact of rounds in the same small area can cause severe damage to range infrastructure and terrain features. Beaten zone analysis is especially critical on heavily used stationary firing position - target combinations; like tank zeroing and on small arms qualification ranges. The designer is responsible for minimizing the risk of damage to critical downrange features or structures.

Line of Sight Philosophy

It is critical during the range design process to provide maximum target visibility for the shooter. With very few exceptions, design the ranges to provide 100% visibility of all required targets. This is critical for qualification ranges in order to maintain qualification standards; extremely little variance is allowed. On some tactical and maneuver ranges, the intent is sometimes to provide more realistic battlefield conditions and in some cases, 100% target visibility may not always be required; some allowances may be possible with the approval of the installation, the MCX, and TCM Ranges. Coordinate with the stakeholders and refer to the individual ranges for specific information on the LoS requirements for each particular range.

Note that there are two different sets of criteria used for ranges, one during the design and construction process and another for training purposes. Design and construct ranges for 100% target visibility with very few exceptions; TCM Ranges, RTLP MCX and the installation, must all be aware of and approve any exceptions. During training, the target is ‘available’ with at least 90% target visibility.

It is the designer’s responsibility to provide the required LoS. The designer must provide sufficient analysis and/or calculations to prove that the proposed design provides all required visibility.

Use the following generally acceptable criteria as a starting point for LoS analysis; coordinate with the stakeholders for each particular range.

Firing Points

The firing point is the point where LoS is required “From”. The control tower, camera locations, etc. can also be “firing points” in a LoS analysis. The designer is responsible for ensuring visibility from every ‘probable’ point within a firing position, both horizontal and vertical. However, the sheer number can make it impractical to analyze all possibilities. As a practical minimum, designers perform LoS analysis from the worst-case horizontal and vertical limits and at discrete points within the firing area. The spacing of the discrete points depends on the type of firing position, the terrain, and the range type.

The following criteria are the minimum typically used.

Vertical

- 6 inches (150mm) above foxhole or prone firing area on small arms qualification ranges
- Lowest barrel or weapon/commander sight heights for all vehicles trained

Note: For ranges where vertical angle of fire is critical or may be an issue, LoS analysis may be required from multiple vertical elevations.

Horizontal

- Center front on single foxholes and prone firing positions
- Four corners and center point on Sniper firing positions
- Start, End, and 50 foot (15 meter) intervals along the centerline of firing box trail
- Center of the pad in both Hull Down and Turret Down positions

Camera

LoS for cameras is typically from a point 1 foot (300mm) above the height of the camera mounting plate.

Control Tower

For visibility from the control tower, assume a seated position behind the counter, (i.e. 3 feet above the floor and 3 feet back from the window). Include any obstructions from the tower itself in the analysis, (e.g. the wall below the window, walkways around the front of the tower, any railings, etc.) as well as any buildings/terrain around the tower that might block visibility.

Target Point

The Target point is where LoS is required “To”. The intent, as stated above, is to provide 100% visibility of the target silhouette. In most cases, a significant portion of the target berm is visible from the firing point, especially on many small arms ranges. On ranges where significant amounts of cut and fill is required to achieve LoS or on ranges that have long distance requirements, visibility is only economically achievable to the very top of the berm. Because computerized LoS tools would show LoS failure from the berm itself, the MCX developed the following Target LoS points used in the LoS tool for design/construction and availability based on the standard emplacement configuration. (On the standard SIT/MIT, the berm is even with the timber, 1 inch (25mm) above the concrete wall. On a SAT/MAT, the berm is 3 inches (75mm) above the concrete wall.)

Small Arms Qualification Ranges

Small arms qualification ranges do not differentiate between design and availability.

Design Criteria

- LoS point on a SIT or MIT is 0.2 inches (5mm) above the berm, [or one tenth of a foot (30mm) above the top of the concrete front wall].
- LoS point on a SAT or MAT is 0.6 inches (15mm) above the berm, [or three tenths of a foot (90mm) above the top of the concrete wall].

Maneuver Ranges

Design Criteria,

The design criteria are the same as that used for small arms qualification ranges.

- LoS point on a SIT or MIT is 0.2 inches (5mm) above the berm, [or one tenth of a foot (30mm) above the top of the concrete front wall].
- LoS point on a SAT or MAT is 0.6 inches (15mm) above the berm, [or three tenths of a foot (90mm) above the top of the concrete wall].

Availability Analysis Criteria

A target is “available” when at least 90% of the target is visible. Use the following criteria based on the standard silhouettes.

- LoS point on a SIT or MIT is 5 inches (130mm) above the berm/timber, [or one-half of a foot (150mm) above the top of the concrete front wall].
- LoS point on a SAT or MAT is 9 inches (230mm) above the berm, [or one foot (300mm) above the top of the wall].

Horizontal

Use the following criteria to ensure that the entire width of the target is visible, and visible along the entire track for moving targets.

- SIT – both sides of the target wall
- SAT – both sides and the center point of the target point
- MIT – both ends and a minimum of 15 feet (5 meter) intervals along the target wall
- MAT – Start and end point of track and a minimum of 150 feet (50 meter) intervals along the target wall.

Ground Clearance

Terrain and vegetation between the firing point and the target are significant issues affecting LoS. Design the range so that the vegetation, when kept at the typical mowing heights at the particular location, does not interfere with LoS. Include a consideration of vegetation growth rates and mowing intervals. Also, consider the fact that shrinking maintenance budgets often means increased mowing intervals and higher vegetation. Include standard construction tolerances and the thickness of added topsoil in the design. At a minimum, design the range so that all lines of sight clear intermediate ground by 6 inches (150mm).

Target Engagement Capability Matrix.

For Mounted Maneuver Ranges, the Project Development Team (PDT), [the designer, the stakeholders (functional range training support personnel at the installation, ACOM, TCM Ranges), and the RTLP MCX] develops the project’s Target Engagement Capability Matrix (capability matrix) based on training standards and the installation’s training requirements at the beginning of the design process. The capability matrix contains the critical engagements that the range must provide in order for the project to meet Army training standards and the MCX uses it to analyze and validate LoS requirements. The matrix starts with a list of required engagements for the range. During the design process, the PDT adds the specific firing point/target combinations that meet those training engagements. The designer must include the capability matrix in each design submittal for validation. Designers should consider hiring their own

functional range training support personnel to aid in the design process. The final design product also includes an availability report. The availability report is a spreadsheet for each firing point showing which targets are visible from that point with the corresponding distance, azimuth, and angle of fire.

AS OF: 26 Jun 12			HBCT Gunnery 3 Sep 09											
ABRAMS TABLE VI DEFENSIVE ENGAGEMENT POSSIBILITIES					Target Specifics of Engagements									
Trail 1	ABRAMS TABLE VI DEFENSIVE ENGAGEMENT POSSIBILITIES	Target Specifics of Engagements												
TT VI	SIGHT AND CONDITIONS	CREWMEMBERS	TARGET TYPE	TARGET POSTURE	Target Specifics of Engagements									
00	OPCH Fall	TC	KE	Mooring	1 Mooring Tank, <800m or >1000m or 800m-2000m	M1 or M2 or M3 or M4	M5 or M6 or M7 or M8 or M9	M10 or M11 or M12 or M13	M14 or M15 or M16 or M17	M18 or M19 or M20 or M21	M22 or M23 or M24 or M25			
01	Machine Gun Pure	Gunner	Coast	Area gr Point	1 Set of Troops, RPG Tn, Mooring Int, Sniper (Fapade) or Technical Truck, <300m or 300m-800m	C01 / M1 / F1 / V01 or C02 / M2 / F2 / V02 or C03 / M3 / F3 / V03 or C04 / M4 / F4 / V04 or C05 / M5 / F5 / V05 or C06 / M6 / F6 / V06 or C07 / M7 / F7 / V07 or C08 / M8 / F8 / V08 or C09 / M9 / F9 / V09 or C10 / M10 / F10 / V10 or C11 / M11 / F11 / V11 or C12 / M12 / F12 / V12 or C13 / M13 / F13 / V13 or C14 / M14 / F14 / V14 or C15 / M15 / F15 / V15 or C16 / M16 / F16 / V16 or C17 / M17 / F17 / V17 or C18 / M18 / F18 / V18 or C19 / M19 / F19 / V19 or C20 / M20 / F20 / V20 or C21 / M21 / F21 / V21 or C22 / M22 / F22 / V22 or C23 / M23 / F23 / V23 or C24 / M24 / F24 / V24 or C25 / M25 / F25 / V25 or C26 / M26 / F26 / V26 or C27 / M27 / F27 / V27 or C28 / M28 / F28 / V28 or C29 / M29 / F29 / V29 or C30 / M30 / F30 / V30 or C31 / M31 / F31 / V31 or C32 / M32 / F32 / V32 or C33 / M33 / F33 / V33 or C34 / M34 / F34 / V34 or C35 / M35 / F35 / V35 or C36 / M36 / F36 / V36 or C37 / M37 / F37 / V37 or C38 / M38 / F38 / V38 or C39 / M39 / F39 / V39 or C40 / M40 / F40 / V40 or C41 / M41 / F41 / V41 or C42 / M42 / F42 / V42 or C43 / M43 / F43 / V43 or C44 / M44 / F44 / V44 or C45 / M45 / F45 / V45 or C46 / M46 / F46 / V46 or C47 / M47 / F47 / V47 or C48 / M48 / F48 / V48 or C49 / M49 / F49 / V49 or C50 / M50 / F50 / V50 or C51 / M51 / F51 / V51 or C52 / M52 / F52 / V52 or C53 / M53 / F53 / V53 or C54 / M54 / F54 / V54 or C55 / M55 / F55 / V55 or C56 / M56 / F56 / V56 or C57 / M57 / F57 / V57 or C58 / M58 / F58 / V58 or C59 / M59 / F59 / V59 or C60 / M60 / F60 / V60 or C61 / M61 / F61 / V61 or C62 / M62 / F62 / V62 or C63 / M63 / F63 / V63 or C64 / M64 / F64 / V64 or C65 / M65 / F65 / V65 or C66 / M66 / F66 / V66 or C67 / M67 / F67 / V67 or C68 / M68 / F68 / V68 or C69 / M69 / F69 / V69 or C70 / M70 / F70 / V70 or C71 / M71 / F71 / V71 or C72 / M72 / F72 / V72 or C73 / M73 / F73 / V73 or C74 / M74 / F74 / V74 or C75 / M75 / F75 / V75 or C76 / M76 / F76 / V76 or C77 / M77 / F77 / V77 or C78 / M78 / F78 / V78 or C79 / M79 / F79 / V79 or C80 / M80 / F80 / V80 or C81 / M81 / F81 / V81 or C82 / M82 / F82 / V82 or C83 / M83 / F83 / V83 or C84 / M84 / F84 / V84 or C85 / M85 / F85 / V85 or C86 / M86 / F86 / V86 or C87 / M87 / F87 / V87 or C88 / M88 / F88 / V88 or C89 / M89 / F89 / V89 or C90 / M90 / F90 / V90 or C91 / M91 / F91 / V91 or C92 / M92 / F92 / V92 or C93 / M93 / F93 / V93 or C94 / M94 / F94 / V94 or C95 / M95 / F95 / V95 or C96 / M96 / F96 / V96 or C97 / M97 / F97 / V97 or C98 / M98 / F98 / V98 or C99 / M99 / F99 / V99 or C100 / M100 / F100 / V100 or C101 / M101 / F101 / V101 or C102 / M102 / F102 / V102 or C103 / M103 / F103 / V103 or C104 / M104 / F104 / V104 or C105 / M105 / F105 / V105 or C106 / M106 / F106 / V106 or C107 / M107 / F107 / V107 or C108 / M108 / F108 / V108 or C109 / M109 / F109 / V109 or C110 / M110 / F110 / V110 or C111 / M111 / F111 / V111 or C112 / M112 / F112 / V112 or C113 / M113 / F113 / V113 or C114 / M114 / F114 / V114 or C115 / M115 / F115 / V115 or C116 / M116 / F116 / V116 or C117 / M117 / F117 / V117 or C118 / M118 / F118 / V118 or C119 / M119 / F119 / V119 or C120 / M120 / F120 / V120 or C121 / M121 / F121 / V121 or C122 / M122 / F122 / V122 or C123 / M123 / F123 / V123 or C124 / M124 / F124 / V124 or C125 / M125 / F125 / V125 or C126 / M126 / F126 / V126 or C127 / M127 / F127 / V127 or C128 / M128 / F128 / V128 or C129 / M129 / F129 / V129 or C130 / M130 / F130 / V130 or C131 / M131 / F131 / V131 or C132 / M132 / F132 / V132 or C133 / M133 / F133 / V133 or C134 / M134 / F134 / V134 or C135 / M135 / F135 / V135 or C136 / M136 / F136 / V136 or C137 / M137 / F137 / V137 or C138 / M138 / F138 / V138 or C139 / M139 / F139 / V139 or C140 / M140 / F140 / V140 or C141 / M141 / F141 / V141 or C142 / M142 / F142 / V142 or C143 / M143 / F143 / V143 or C144 / M144 / F144 / V144 or C145 / M145 / F145 / V145 or C146 / M146 / F146 / V146 or C147 / M147 / F147 / V147 or C148 / M148 / F148 / V148 or C149 / M149 / F149 / V149 or C150 / M150 / F150 / V150 or C151 / M151 / F151 / V151 or C152 / M152 / F152 / V152 or C153 / M153 / F153 / V153 or C154 / M154 / F154 / V154 or C155 / M155 / F155 / V155 or C156 / M156 / F156 / V156 or C157 / M157 / F157 / V157 or C158 / M158 / F158 / V158 or C159 / M159 / F159 / V159 or C160 / M160 / F160 / V160 or C161 / M161 / F161 / V161 or C162 / M162 / F162 / V162 or C163 / M163 / F163 / V163 or C164 / M164 / F164 / V164 or C165 / M165 / F165 / V165 or C166 / M166 / F166 / V166 or C167 / M167 / F167 / V167 or C168 / M168 / F168 / V168 or C169 / M169 / F169 / V169 or C170 / M170 / F170 / V170 or C171 / M171 / F171 / V171 or C172 / M172 / F172 / V172 or C173 / M173 / F173 / V173 or C174 / M174 / F174 / V174 or C175 / M175 / F175 / V175 or C176 / M176 / F176 / V176 or C177 / M177 / F177 / V177 or C178 / M178 / F178 / V178 or C179 / M179 / F179 / V179 or C180 / M180 / F180 / V180 or C181 / M181 / F181 / V181 or C182 / M182 / F182 / V182 or C183 / M183 / F183 / V183 or C184 / M184 / F184 / V184 or C185 / M185 / F185 / V185 or C186 / M186 / F186 / V186 or C187 / M187 / F187 / V187 or C188 / M188 / F188 / V188 or C189 / M189 / F189 / V189 or C190 / M190 / F190 / V190 or C191 / M191 / F191 / V191 or C192 / M192 / F192 / V192 or C193 / M193 / F193 / V193 or C194 / M194 / F194 / V194 or C195 / M195 / F195 / V195 or C196 / M196 / F196 / V196 or C197 / M197 / F197 / V197 or C198 / M198 / F198 / V198 or C199 / M199 / F199 / V199 or C200 / M200 / F200 / V200 or C201 / M201 / F201 / V201 or C202 / M202 / F202 / V202 or C203 / M203 / F203 / V203 or C204 / M204 / F204 / V204 or C205 / M205 / F205 / V205 or C206 / M206 / F206 / V206 or C207 / M207 / F207 / V207 or C208 / M208 / F208 / V208 or C209 / M209 / F209 / V209 or C210 / M210 / F210 / V210 or C211 / M211 / F211 / V211 or C212 / M212 / F212 / V212 or C213 / M213 / F213 / V213 or C214 / M214 / F214 / V214 or C215 / M215 / F215 / V215 or C216 / M216 / F216 / V216 or C217 / M217 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or C252 / M252 / F252 / V252 or C253 / M253 / F253 / V253 or C254 / M254 / F254 / V254 or C255 / M255 / F255 / V255 or C256 / M256 / F256 / V256 or C257 / M257 / F257 / V257 or C258 / M258 / F258 / V258 or C259 / M259 / F259 / V259 or C260 / M260 / F260 / V260 or C261 / M261 / F261 / V261 or C262 / M262 / F262 / V262 or C263 / M263 / F263 / V263 or C264 / M264 / F264 / V264 or C265 / M265 / F265 / V265 or C266 / M266 / F266 / V266 or C267 / M267 / F267 / V267 or C268 / M268 / F268 / V268 or C269 / M269 / F269 / V269 or C270 / M270 / F270 / V270 or C271 / M271 / F271 / V271 or C272 / M272 / F272 / V272 or C273 / M273 / F273 / V273 or C274 / M274 / F274 / V274 or C275 / M275 / F275 / V275 or C276 / M276 / F276 / V276 or C277 / M277 / F277 / V277 or C278 / M278 / F278 / V278 or C279 / M279 / F279 / V279 or C280 / M280 / F280 / V280 or C281 / M281 / F281 / V281 or C282 / M282 / F282 / V282 or C283 / M283 / F283 / V283 or C284 / M284 / F284 / V284 or C285 / M285 / F285 / V285 or C286 / M286 / F286 / V286 or C287 / M287 / F287 / V287 or C288 / M288 / F288 / V288 or C289 / M289 / F289 / V289 or C290 / M290 / F290 / V290 or C291 / M291 / F291 / V291 or C292 / M292 / F292 / V292 or C293 / M293 / F293 / V293 or C294 / M294 / F294 / V294 or C295 / M295 / F295 / V295 or C296 / M296 / F296 / V296 or C297 / M297 / F297 / V297 or C298 / M298 / F298 / V298 or C299 / M299 / F299 / V299 or C300 / M300 / F300 / V300 or C301 / M301 / F301 / V301 or C302 / M302 / F302 / V302 or C303 / M303 / F303 / V303 or C304 / M304 / F304 / V304 or C305 / M305 / F305 / V305 or C306 / M306 / F306 / V306 or C307 / M307 / F307 / V307 or C308 / M308 / F308 / V308 or C309 / M309 / F309 / V309 or C310 / M310 / F310 / V310 or C311 / M311 / F311 / V311 or C312 / M312 / F312 / V312 or C313 / M313 / F313 / V313 or C314 / M314 / F314 / V314 or C315 / M315 / F315 / V315 or C316 / M316 / F316 / V316 or C317 / M317 / F317 / V317 or C318 / M318 / F318 / V318 or C319 / M319 / F319 / V319 or C320 / M320 / F320 / V320 or C321 / M321 / F321 / V321 or C322 / M322 / F322 / V322 or C323 / M323 / F323 / V323 or C324 / M324 / F324 / V324 or C325 / M325 / F325 / V325 or C326 / M326 / F326 / V326 or C327 / M327 / F327 / V327 or C328 / M328 / F328 / V328 or C329 / M329 / F329 / V329 or C330 / M330 / F330 / V330 or C331 / M331 / F331 / V331 or C332 / M332 / F332 / V332 or C333 / M333 / F333 / V333 or C334 / M334 / F334 / V334 or C335 / M335 / F335 / V335 or C336 / M336 / F336 / V336 or C337 / M337 / F337 / V337 or C338 / M338 / F338 / V338 or C339 / M339 / F339 / V339 or C340 / M340 / F340 / V340 or C341 / M341 / F341 / V341 or C342 / M342 / F342 / V342 or C343 / M343 / F343 / V343 or C344 / M344 / F344 / V344 or C345 / M345 / F345 / V345 or C346 / M346 / F346 / V346 or C347 / M347 / F347 / V347 or C348 / M348 / F348 / V348 or C349 / M349 / F349 / V349 or C350 / M350 / F350 / V350 or C351 / M351 / F351 / V351 or C352 / M352 / F352 / V352 or C353 / M353 / F353 / V353 or C354 / M354 / F354 / V354 or C355 / M355 / F355 / V355 or C356 / M356 / F356 / V356 or C357 / M357 / F357 / V357 or C358 / M358 / F358 / V358 or C359 / M359 / F359 / V359 or C360 / M360 / F360 / V360 or C361 / M361 / F361 / V361 or C362 / M362 / F362 / V362 or C363 / M363 / F363 / V363 or C364 / M364 / F364 / V364 or C365 / M365 / F365 / V365 or C366 / M366 / F366 / V366 or C367 / M367 / F367 / V367 or C368 / M368 / F368 / V368 or C369 / M369 / F369 / V369 or C370 / M370 / F370 / V370 or C371 / M371 / F371 / V371 or C372 / M372 / F372 / V372 or C373 / M373 / F373 / V373 or C374 / M374 / F374 / V374 or C375 / M375 / F375 / V375 or C376 / M376 / F376 / V376 or C377 / M377 / F377 / V377 or C378 / M378 / F378 / V378 or C379 / M379 / F379 / V379 or C380 / M380 / F380 / V380 or C381 / M381 / F381 / V381 or C382 / M382 / F382 / V382 or C383 / M383 / F383 / V383 or C384 / M384 / F384 / V384 or C385 / M385 / F385 / V385 or C386 / M386 / F386 / V386 or C387 / M387 / F387 / V387 or C388 / M388 / F388 / V388 or C389 / M389 / F389 / V389 or C390 / M390 / F390 / V390 or C391 / M391 / F391 / V391 or C392 / M392 / F392 / V392 or C393 / M393 / F393 / V393 or C394 / M394 / F394 / V394 or C395 / M395 / F395 / V395 or C396 / M396 / F396 / V396 or C397 / M397 / F397 / V397 or C398 / M398 / F398 / V398 or C399 / M399 / F399 / V399 or C400 / M400 / F400 / V400 or C401 / M401 / F401 / V401 or C402 / M402 / F402 / V402 or C403 / M403 / F403 / V403 or C404 / M404 / F404 / V404 or C405 / M405 / F405 / V405 or C406 / M406 / F406 / V406 or C407 / M407 / F407 / V407 or C408 / M408 / F408 / V408 or C409 / M409 / F409 / V409 or C410 / M410 / F410 / V410 or C411 / M411 / F411 / V411 or C412 / M412 / F412 / V412 or C413 / M413 / F413 / V413 or C414 / M414 / F414 / V414 or C415 / M415 / F415 / V415 or C416 / M416 / F416 / V416 or C417 / M417 / F417 / V417 or C418 / M418 / F418 / V418 or C419 / M419 / F419 / V419 or C420 / M420 / F420 / V420 or C421 / M421 / F421 / V421 or C422 / M422 / F422 / V422 or C423 / M423 / F423 / V423 or C424 / M424 / F424 / V424 or C425 / M425 / F425 / V425 or C426 / M426 / F426 / V426 or C427 / M427 / F427 / V427 or C428 / M428 / F428 / V428 or C429 / M429 / F429 / V429 or C430 / M430 / F430 / V430 or C431 / M431 / F431 / V431 or C432 / M432 / F432 / V432 or C433 / M433 / F433 / V433 or C434 / M434 / F434 / V434 or C435 / M435 / F435 / V435 or C436 / M436 / F436 / V436 or C437 / M437 / F437 / V437 or C438 / M438 / F438 / V438 or C439 / M439 / F439 / V439 or C440 / M440 / F440 / V440 or C441 / M441 / F441 / V441 or C442 / M442 / F442 / V442 or C443 / M443 / F443 / V443 or C444 / M444 / F444 / V444 or C445 / M445 / F445 / V445 or C446 / M446 / F446 / V446 or C447 / M447 / F447 / V447 or C448 / M448 / F448 / V448 or C449 / M449 / F449 / V449 or C450 / M450 / F450 / V450 or C451 / M451 / F451 / V451 or C452 / M452 / F452 / V452 or C453 / M453 / F453 / V453 or C454 / M454 / F454 / V454 or C455 / M455 / F455 / V455 or C456 / M456 / F456 / V456 or C457 / M457 / F457 / V457 or C458 / M458 / F458 / V458 or C459 / M459 / F459 / V459 or C460 / M460 / F460 / V460 or C461 / M461 / F461 / V461 or C462 / M462 / F462 / V462 or C463 / M463 / F463 / V463 or C464 / M464 / F464 / V464 or C465 / M465 / F465 / V465 or C466 / M466 / F466 / V466 or C467 / M467 / F467 / V467 or C468 / M468 / F468 / V468 or C469 / M469 / F469 / V469 or C470 / M470 / F470 / V470 or C471 / M471 / F471 / V471 or C472 / M472 / F472 / V472 or C473 / M473 / F473 / V473 or C474 / M474 / F474 / V474 or C475 / M475 / F475 / V475 or C476 / M476 / F476 / V476 or C477 / M477 / F477 / V477 or C478 / M478 / F478 / V478 or C479 / M479 / F479 / V479 or C480 / M480 / F480 / V480 or C481 / M481 / F481 / V481 or C482 / M482 / F482 / V482 or C483 / M483 / F483 / V483 or C484 / M484 / F484 / V484 or C485 / M485 / F485 / V485 or C486 / M486 / F486 / V486 or C487 / M487 / F487 / V487 or C488 / M488 / F488 / V488 or C489 / M489 / F489 / V489 or C490 / M490 / F490 / V490 or C491 / M491 / F491 / V491 or C492 / M492 / F492 / V492 or C493 / M493 / F493 / V493 or C494 / M494 / F494 / V494 or C495 / M495 / F495 / V495 or C496 / M496 / F496 / V496 or C497 / M497 / F497 / V497 or C498 / M498 / F498 / V498 or C499 / M499 / F499 / V499 or C500 / M500 / F500 / V500 or C501 / M501 / F501 / V501 or C502 / M502 / F502 / V502 or C503 / M503 / F503 / V503 or C504 / M504 / F504 / V504 or C505 / M505 / F505 / V505 or C506 / M506 / F506 / V506 or C507 / M507 / F507 / V507 or C508 / M508 / F508 / V508 or C509 / M509 / F509 / V509 or C510 / M510 / F510 / V510 or C511 / M511 / F511 / V511 or C512 / M512 / F512 / V512 or C513 / M513 / F513 / V513 or C514 / M514 / F514 / V514 or C515 / M515 / F515 / V515 or C516 / M516 / F516 / V516 or C517 / M517 / F517 / V517 or C518 / M518 / F518 / V518 or C519 / M519 / F519 / V519 or C520 / M520 / F520 / V520 or C521 / M521 / F521 / V521 or C522 / M522 / F522 / V522 or C523 / M523 / F523 / V523 or C524 / M524 / F524 / V524 or C525 / M525 / F525 / V525 or C526 / M526 / F526 / V526 or C527 / M527 / F527 / V527 or C528 / M528 / F528 / V528 or C529 / M529 / F529 / V529 or C530 / M530 / F530 / V530 or C531 / M531 / F531 / V531 or C532 / M532 / F532 / V532 or C533 / M533 / F533 / V533 or C534 / M534 / F534 / V534 or C535 / M535 / F535 / V535 or C536 / M536 / F536 / V536 or C537 / M537 / F537 / V537 or C538 / M538 / F538 / V538 or C539 / M539 / F539 / V539 or C540 / M540 / F540 / V540 or C541 / M541 / F541 / V541 or C542 / M542 / F542 / V542 or C543 / M543 / F543 / V543 or C544 / M544 / F544 / V544 or C545 / M545 / F545 / V545 or C546 / M546 / F546 / V546 or C547 / M547 / F547 / V547 or C548 / M548 / F548 / V548 or C549 / M549 / F549 / V549 or C550 / M550 / F550 / V550 or C551 / M551 / F551 / V551 or C552 / M552 / F552 / V552 or C553 / M553 / F553 / V553 or C554 / M554 / F554 / V554 or C555 / M555 / F555 / V555 or C556 / M556 / F556 / V556 or C557 / M557 / F557 / V557 or C558 / M558 / F558 / V558 or C559 / M559 / F559 / V559 or C560 / M560 / F560 / V560 or C561 / M561 / F561 / V561 or C562 / M562 / F562 / V562 or C563 / M563 / F563 / V563 or C564 / M564 / F564 / V564 or C565 / M565 / F565 / V565 or C566 / M566 / F566 / V566 or C567 / M567 / F567 / V567 or C568 / M568 / F568 / V568 or C569 / M569 / F569 / V569 or C570 / M570 / F570 / V570 or C571 / M571 / F571 / V571 or C572 / M572 / F572 / V572 or C573 / M573 / F573 / V573 or C574 / M574 / F574 / V574 or C575 / M575 / F575 / V575 or C576 / M576 / F576 / V576 or C577 / M577 / F577 / V577 or C578 / M578 / F578 / V578 or C579 / M579 / F579 / V579 or C580 / M580 / F580 / V580 or C581 / M581 / F581 / V581 or C582 / M582 / F582 / V5								

LoS Data Submittal Requirements

The submittal requirements to the RTLP MCX depend on the type of range. The following paragraphs and each individual range section in the RDG document the requirements for each type.

Small Arms Qualification Ranges

The designer is required to submit profiles for each required firing position to target combination.

Mounted Maneuver Ranges

The designer is required to submit a LoS report and provide the following information to the RTLP MCX for LoS analysis and validation on Mounted Maneuver Ranges:

Preferred Data Submittal

All data should be delivered in a single parent folder with the following sub-folder structure:

1. **Submittal Summary Document**
2. **CAD Folder** containing:
 - a. Existing Topography (.dwg)
 - b. Proposed Site Plan (.dwg)
 - c. Erosion Control (.dwg)
3. **Details folder** containing:
 - a. Civil Detail Sheets (PDF)
4. **LOS Input Data folder** containing:
 - a. Lines folder containing
 - i. 3D Polylines - firing and target lines (.dwg)
 - b. Nodes folder containing
 - i. Nodes – firing, target, and camera points (CSV)
5. **Surfaces folder** containing:
 - a. Grading (.dwg)
 - b. Earthwork Site Plan - polygons of features to be constructed (.dwg)
 - c. Facades (.dwg)

Descriptions of each above listed item are included in the following sections.

Submittal Summary Document

The designer will provide a PDF summary document detailing the standards used for the design. This document is crucial for correctly interpreting the data and must include:

- a. **Layering Standard:** The layer/level naming convention and a description of the data on each layer.
- b. **Coordinate System:** The full name and parameters of the spatial reference system used (e.g., NAD 1983 HARN StatePlane Florida East FIPS 0901 (US Feet)). All data must be delivered in this single, consistent projection.
- c. **Drawing Units:** The units used in the design (e.g., US Feet).
- d. **Naming Conventions:** A clear explanation of the naming scheme for targets and firing points.

- e. **Target Engagement Capability Matrix:** The matrix mapping all target-to-firing-point pairings, utilizing the exact naming conventions established in item d, to facilitate the RTLP-MCX Line of Sight (LoS) validation.
- f. **File Inventory:** A list of all files included in the submittal and a brief description of the data contained within each file.

CAD Models and Plans

Existing Surface Model

The designer will provide an existing surface digital terrain model using one of the following formats:

- a) AutoCAD Civil 3D surface
- b) Land XML Format
- c) Electronic **comma or space** delimited ASCII formatted files containing digital surface information. Each type of data should be in a separate file. The file formats are as follows:
 - a. Random Points should have the following format: ID*, Northing, Easting, Elevation, Feature*
 - b. Breakline Information:
 - i. ID, Northing, Easting Elevation, Feature, Pencode
 - ii. Pencode - This field defines for each linear feature a zero (0) or one (1). A one identifies the first point of a linear component followed other points within the line having zero. The next new line will start with one.
 - c. For electronic **comma or space** delimited ASCII formatted files containing triangle point information (TIN), the file format is as follows:
 - i. Random Points should have the following format: ID, Northing, Easting, Elevation, Feature

Relevant drawings like erosion control and site plan should also be included for reference during the LOS analysis process.

LOS Input Data

Trail / Moving Target Emplacement Locations

- a. Electronic file containing 3D graphic alignments shown at zero elevation at the centerline of trails and moving target emplacements
- b. Profile of existing and proposed alignments and associated profile report in text format.

Stationary Target Emplacement

Electronic comma delimited (CSV)

ASCII formatted file with the following information:

- Point ID
- Name
- Northing

- Easting
- Elevation

Spatial reference system should be specifically named in the summary document.

Start / End Trail Firing Positions

In an electronic CAD file, the designer must locate and label starting and ending firing positions along the trails.

Surfaces (Proposed)

Proposed Range Digital Terrain

The designer must provide proposed grading drawings including all trails, firing positions, target locations, and any other site grading/obstruction data required on the project. Please create a .dwg file for each of the following:

- a. Grading file containing 3D lines of proposed grading for the site
- b. Earthwork Site Plan file containing 3D polygon outlines of features to be constructed
- c. Facades file containing 3D polygon outlines of façade structures

Each feature should have elevation information and should be reviewed to mitigate placeholder values.

NOTE: "short segments" may not fit tolerances for the MCX's line-of-sight tool. Please review data and vertices to prevent overlap and geometric redundancies.