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#### DEPARTMENT OF THE ARMY THE JUDGE ADVOCATE GENERAL'S SCHOOL 600 MASSIE ROAD CHARLOTTESVILLE, VIRGINIA 22903-1781

REPLY TO ATTENTION OF

August 30, 2011

Administrative and Civil Law Department

I am writing in response to your Freedom of Information Act (FOIA) request for the slides used in the CLAMO class, "An Introduction to Formal Collateral Damage Estimation for Judge Advocates." Enclosed please find all releasable documents that are responsive to your request.

A complete copy of the slide presentation is enclosed, subject to minimal redactions pursuant to applicable FOIA exemptions. All redactions in the documents provided have been made under Exemption b(1) that prohibits the release of properly classified documents. These classified materials were included as examples for training purposes. They remain substantively and procedurally properly classified under Executive Order 12958 and are thereby withheld from release pursuant to FOIA.

There are no assessable fees associated with the processing of your request.

The Initial Denial Authority for the withheld material is Commanding General, The Judge Advocate General's Legal Center and School (ALCS-ZA). If you wish to obtain a decision from TJAG or have any other questions about this response, please contact me at (434) 971-3167 or Kelly.j.armstrong@us.army.mil.

Sincerely,

LCDR. US Navv

Enclosure



### An Introduction to the Collateral Damage Methodology (CDM) and the Collateral Damage Estimate (CDE)

2009 OC/OT/TM Symposium







### Agenda

- What is a CDE?
- Why study the CDM and resulting CDEs?
- The CDM Process
  - Technical Framework
  - CDE Levels 1 5
- Final Thought







### What is a CDE?

		Final	CDE Assessment		
CDE Level	Low / High	Weapon Class (PGM/ASUGM/SSBM)	Weaponeering Restriction	Heading Restriction	Casualty Estimate
CDE				*	D: N: E:

- A product of the process of the "Joint Methodology for Estimating Collateral Damage and Casualties for Conventional Weapons: Precision, Unguided, and Cluster"
- The process is found in \* CJCSM 3160.01B, 31 August 2007



#### CHAIRMAN OF THE JOINT CHIEFS OF STAFF MANUAL

J-2 DISTRIBUTION: A. C. J. S CJCSM 3160.01B 31 August 2007

JOINT METHODOLOGY FOR ESTIMATING COLLATERAL DAMAGE AND CASUALTIES FOR CONVENTIONAL WEAPONS. PRECISION, UNGUIDED, AND CLUSTER

References:

a. CUCSI 3110-01 series, "Joint Strategic Capabilities Plan (U)"
 b. CUCSI 3122.06 series, "Sensitive Target Approval and Review (STAR)

Process (U)" c. CJC81 3227.01 series, "No-Strike Policy and Guidance"

1. Purpose

a. The Law of War (LOW) requires reasonable precautions to ensure only legitimate military objects are targeted. The LOW requires combatants to refrain from intensionally targeting civilian or moscombatant populations or facilities. The LOW also utipulates that anticipated civilian or noncombatant injury or loss of Ele and damage to civilian or noncombatant propulsions and damage to civilian or noncombatant propulsion and damage to civilian or noncombatant propulsion and damage to civilian or noncombatant property incidentel is attack: must not be expected military advantage to be gained. Failure to observe these obligations could result in diproportionate negative effects on civilians and noncombatant and be considered a LOW volcion. Furthermore, US leadership and military objectives and national goals:

b. The US government places a high value on preserving civilian and nencombatant lives. The US military must emulate and represent these values through the conscientious use of force in the accomplishment of assigned military missions.

c. This manual establishes the collateral damage estimation (CDE) construct and the overarching joint collateral damage estimation methodology (CDM). The CDM encomparises the joint standards, methods, techniques, and processes for a commander to conduct CDE and mitigate unintended or incidental damage or injury to civilian or noncombatent persons or property or



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# What is the CDM?

- The Collateral Damage Methodology (CDM):
  - Balance of science and art that produces the best judgment of potential damage to collateral concerns
  - Results in the CDE
  - Encompasses the joint standards, methods, techniques, and processes for a commander to:
    - Conduct CDE and
    - Mitigate unintended or incidental damage or injury to civilian or noncombatant persons or property or the environment
  - Assists commanders in weighing risk against military necessity and in assessing proportionality within the framework of the military decision-making process
- In short, the CDM is a means for assisting a commander in adhering to the Law of War (LoW)



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## What the CDM is Not

- Not an exact science:
  - Supporting technical data and processes of the methodology are derived from physics-based computer models, weapons test data, and operational combat observations
  - All contain some degree of inherent error and uncertainty
- Not itself a decision:
  - Merely informs a commander's decision
  - Its application relies on sound judgment
- Not the only input to a commander's decision making:
  - Target characteristics, operational objectives, strategic communications, LOW, and rules of engagement (ROE) are just some other factors
  - These other factors, either alone or in combination, may frequently outweigh the value of the CDM input
- Not always predict the actual outcome of weapon employment:
  - Intelligence fidelity and timeliness, operational considerations, and weapon reliability are some reasons for differences
- Not a limit on a commander's inherent right of self-defense





# Why Study the CDM and resulting CDEs?

- Knowledge allows you to speak the language of your client
- Knowledge allows the you to find ways to get to "Yes" for your client
- Formal certification in the CDE methodology provides instant credibility with your client
- Most importantly, it is an integral part of the rules of engagement







## In Iraq

 Appendix 6 (Kinetic Targeting Guidance) to Annex E (Rules of Engagement) to b(1)

### b(1)

b(1) – post-UNSCR

 17 page document contains the abbreviation "CDE" or "CDM" 67 times





## The CDM Process – Technical Framework

- Enables a reasonable determination of collateral damage inherent in weapons employment
- Thereby addresses the LoW requirement for reasonable precautions to minimize effects of combat on the civilian or noncombatant population
- Designed to be simple and repeatable
  - Used in a deliberate manner where time is not a factor or in situations where time is critical
  - Used with or without the aide of an automated CDE tool



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### The CDM Process – Limits and Exclusions

- Accounts for all conventional munitions currently in the US inventory (No nukes!)
- Not required for surface-to-surface direct fire weapon systems or air-to-surface direct fire weapon systems less than 105mm (Apply normal Law of War analysis)
- Does not account for:
  - Weapon malfunction, operational delivery errors, or altered delivery tactics based on aircrew judgment
  - Unknown transient civilian or noncombatant personnel and/or property (e.g., vehicles or pedestrians) in the target area
  - Individual marking or adjusting rounds when employing surfaceto-surface ballistic munitions (SSBM) in the Observer Adjusted method of engagement
  - Use of cluster or improved conventional munitions (ICM) beyond CDE Level 3
  - Rocket Assisted Projectiles (RAPs) or enhanced/extended range artillery, mortar, and naval gun munitions beyond CDE Level 3





### **CDM Process Quick** Guide

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CDE Level 1			CDE Level 4		
Positive ID	Yes	No	Assess and record collateral	1	
Defined Facility Boundary	Yes	No	structure type(s)		
Authorized by ROE	Yes	No	Select and enter CDE Level 4 weaponeering solution		
Dual-Use Facility	No	Yes	Is COFI evel 4 Bull for the	Yes	No
Collateral Objects in CHA	No	Yes	weaponeering solution less	100	
CBR Plume Hazard	No	Yes	than the distance calculated in CDE Level 3?		
Environmental Hazard	No	Yes	Assessment	Low	Mg
CDE Level 1 Assessment	Low	Httph	Delivery Heading restrictions		
CDE Level 2			Other mitigation techniques		
Minimum Target Size Feasibility	Yes	No			
Yes - Proceed to CDE Level 3 No - Consider PGM Only			Assess each unshielded collater, functionality from the CDE Level Density Reference Table and rec CDE Level 5 Casualty Estimation	al concern 5 Populatio cord on the 10/ork sheet	⇒n et
Collateral Objects in CHA?	No	res	Compute the affected area (sq ft) unshielded collateral concern and CDE Loval & Complex Externation	) of each d record in	the
CDE Level 2 Assessment	Low	14(32)	CDE Lever 5 Castianty Estimation	I WOUR SILE	53. 
CDE Level 3  Measure and record distance			Select the population density for episodic from the CDE Level 5 P Reference Table and record in th Casuality Estimation Worksheet	opulation C opulation C re CDE Lev	ano Jersit vel 5
from aimpoint(s), ASUGM EZ or SSBM sheaf to nearest collateral concern(s)		4	Determine the appropriate casua collateral concern and record in t Casualty Estimation Worksheet	ity factor fo the CDE Le	xreac avel 5
Is there a weaponeering solution Using CDE Level 3	Yes	No	Compute the casualty Day :		
BMD Tables to achieve desired			estimate, adding any DTRA or AFMIC casuabr estimate	tte, adding any DTRA or Night:	
effect with and BMD less than the distance above?			a a recense sense sense y second comestic	Episodic	): :
CDE Level 3Assessment	Low	High	is the computed casualty	Yes	No
Weapon/Fuse Restrictions			estimate less than the NCV?		
			Assessment	Low	1 4 3







- Five mutually dependent CDE levels (CDE Level 1 through Level 5)
- Each level is based on a <u>progressively</u> <u>refined</u> analysis of
  - Available intelligence,
  - Weapon types and effects,
  - Physical environment,
  - Target characteristics and
  - Delivery scenarios



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### **Progressive Refinement**

- At each CDE level an assessment of either Low or High
- If collateral concerns are not within the computed collateral hazard area (CHA) or the specified level of risk to collateral concerns is not met:
  - The assessment is LOW and
  - A higher CDE level assessment is not needed
- If the assessment is HIGH (something is within the CHA), you move to the next CDE level





- Effective Miss Distance (EMD) and Collateral Hazard Area (CHA) are two fundamental elements of the CDM that determine the progression from each CDE level
- Essentially, an EMD is a radius of collateral weapons effects which is used to form a CHA
- The assessment conducted at each CDE level is based on the existence of collateral concerns within the corresponding CHA
- Within a CHA there is an unacceptable probability for damage or injury to collateral concerns, which include persons and objects
- Each succeeding CDE level employs mitigation techniques and weaponeering restrictions designed to reduce the area of collateral effects to an acceptable level







### **Risk Relationship**



——— Risk of Collateral Damage

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#### CDE Level 1 - Target Development and Initial Assessment

- Initial assessment for all conventional weapons
- Dominant hazard is fragmentation versus personnel
- Reduces the risk of serious/lethal injury to standing personnel from primary warhead fragmentation or debris effects to less than 10 percent probability with a high confidence level
- Consequently, the risk of damage to collateral structures is also mitigated
- Targets assessed as CDE Level 1 Low present the lowest probability of collateral damage and have no tactical restrictions on execution
- Present the least risk to mission for commander







CDE Level 1		
Positive ID	Yes	No
Defined Facility Boundary	Yes	No
Authorized by ROE	Yes	No
Dual Use Facility	No	Yes
Collateral Objects in the CHA	No	Yes
CBR Plume Hazard	No	Yes
Environmental Hazard	No	Yes
CDE Level 1 Assessment	Low	High







#### CDE Level 1

Positive ID	Yes	No
Defined Facility Boundary	Yes	No
Authorized by ROE	Yes	No
Dual Use Facility	No	Yes
Collateral Objects in the CHA	No	Yes
CBR Plume Hazard	No	Yes
Environmental Hazard	No	Yes
CDE Level 1 Assessment	Low	High









CDE Level 1			_
Positive ID	Yes	No	
Defined Facility Boundary	Yes	No	
Authorized by ROE	Yes	No	
Dual Use Facility	No	Yes	
Collateral Objects in the CHA	No	Yes	
CBR Plume Hazard	No	Yes	
Environmental Hazard	No	Yes	
CDE Level 1 Assessment	Low	High	

DTRA and/or AFMIC Analysis Perform casualty estimate





CDE Level 1		
Positive ID	Yes	No
Defined Facility Boundary	Yes	No
Authorized by ROE	Yes	No
Dual Use Facility	No	Yes
Collateral Objects in the CHA	No	Yes
CBR Plume Hazard	No	Yes
Environmental Hazard	No	Yes
CDE Level 1 Assessment	Low	High

Go directly to CDE Level 5 Assessment





CDE Level 1		
Positive ID	Yes	No
Defined Facility Boundary	Yes	No
Authorized by ROE	Yes	No
Dual Use Facility	No	Yes
Collateral Objects in the CHA	No	Yes
CBR Plume Hazard	No	Yes
Environmental Hazard	No	Yes
CDE Level 1 Assessment	Low	High

Assess as CDE Level 1 High Conduct CDE Level 2 Assessment



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### **CDE Level 1**

CDE Level 1		
Positive ID	Yes	No
Defined Facility Boundary	Yes	No
Authorized by ROE	Yes	No
Dual Use Facility	No	Yes
Collateral Objects in the CHA	No	Yes
CBR Plume Hazard	No	Yes
Environmental Hazard	No	Yes
CDE Level 1 Assessment	Low	High

Assess as CDE Level 1 High Conduct CDE Level 2 Assessment





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### **CDE Level 1**

CDE Level 1		
Positive ID	Yes	No
Defined Facility Boundary	Yes	No
Authorized by ROE	Yes	No
Dual Use Facility	No	Yes
Collateral Objects in the CHA	No	Yes
CBR Plume Hazard	No	Yes
Environmental Hazard	No	Yes
CDE Level 1 Assessment	Low	High

Assess as CDE Level 1 LOW

Engage with any conventional weapon in the inventory

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### **CDE** Tables

- Each CDE level uses a different table
- Published by the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME)
- Beyond the first level (CDE 1) the CDM also assigns sub-groupings (A, B, or C) to address collateral damage probabilities for specific weapon types, mitigation techniques, and target sizes
  - Sub-group A: Precision Guided Munitions (PGM)
  - Sub-group B: Air-to-Surface Unguided Munition (ASUGM)
  - Sub-group C: Surface-to-Surface Ballistic Munition (SSBM)



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### CDE Level 2 - General and Target Size Assessment

 Begins the process of collateral damage mitigation by selecting a weapon class to employ against a target

#### Employs two distinct assessments:

#### Minimum target size assessment

- Provides a simple means to determine the feasibility of engaging a target with unguided or ballistic weapons
- Uses Tables 2B and 2C
- Precision Guided Munition (PGM) general assessment
  - Evaluates the risk of collateral damage by employing either a unitary or cluster PGM without having to select a specific unitary or cluster warhead
  - Uses Table 2A







- Dominant hazard
  - Table 2A: Remains fragmentation versus personnel
  - Tables 2B and 2C: Delivery error only
- All three still geared to reduces the risk of serious/lethal injury to standing personnel to less than 10 percent probability
- B and 2C do not produce a HIGH or LOW assessment, they determine feasibility only







Minimum Target Size Feasibility (Tables 2B/2C) ASUGM or SSBM	Yes	No
PGM General Assessment (Table 2A Unitary or Cluster) Collateral Objects in CHA?	No	Yes
CDE Level 2 Assessment	Low	High







CDE Level 2		
Minimum Target Size Feasibility (Tables 2B/2C) ASUGM or SSBM	Yes	No
PGM General Assessment (Table 2A Unitary or Cluster) Collateral Objects in CHA?	No	Yes
CDE Level 2 Assessment	Low	High

Conduct CDE Level 3 Assessment







S	Im Target	/inimu	N
	Level 2	CDE L	0

Minimum Target Size Feasibility (Tables 2B/2C) ASUGM or SSBM	Yes	No
PGM General Assessment (Table 2A Unitary or Cluster) Collateral Objects in CHA?	No	Yes
CDE Level 2 Assessment	Low	High

#### Consider PGM Only







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( -				•)
C			V CI	4

Minimum Target Size Feasibility (Tables 2B/2C) ASUGM or SSBM	Yes	No
PGM General Assessment (Table 2A Unitary or Cluster) Collateral Objects in CHA?	No	Yes
CDE Level 2 Assessment	Low	High

Assess as CDE Level 2 Low Use the appropriate PGM







		_	_
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		$  \boldsymbol{\Theta}  $	
			6

Minimum Target Size Feasibility (Tables 2B/2C) ASUGM or SSBM	Yes	No
PGM General Assessment (Table 2A Unitary or Cluster) Collateral Objects in CHA?	No	Yes
CDE Level 2 Assessment	Low	High

Assess as CDE Level 2 High Conduct CDE Level 3 Assessment



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### CDE Level 3 - Weaponeering Assessment

- Now we are picking which specific weapon to use
- Also has three supporting EMD reference tables
- Table 3A for PGMs has two values that deal with two different hazards:
  - Unmitigated: air or surface burst warhead fuzing; dominant hazard is from fragmentation to standing, unprotected personnel dressed in a summer-weight uniform on open rolling terrain
  - Mitigated: represents the hazard distance from crater ejecta/debris to standing unprotected personnel; is only warheads capable of delay fusing to achieve complete burial below grade prior to detonation







CDE Level 3		
Measure distance from aimpoints to the nearest collateral concern		
Is there a weaponeering solution using Level 3 Tables with an EMD less than the distance above?	Yes	No
CDE Level 3 Assessment	Low	High
Weapon/Fuse Restrictions		







CDE Level 3		
Measure distance from aimpoints to the nearest collateral concern		
Is there a weaponeering solution using Level 3 Tables with an EMD less than the distance above?	Yes	No
CDE Level 3 Assessment	Low	High
Weapon/Fuse Restrictions		

Assess as CDE Level 3 Low Use the chosen weapon/

fuse solution

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CDE Level 3		
Measure distance from aimpoints to the nearest collateral concern		
Is there a weaponeering solution using Level 3 Tables with an EMD less than the distance above?	Yes	No
CDE Level 3 Assessment	Low	High
Weapon/Fuse Restrictions		

Assess as CDE Level 3 High Conduct CDE Level 4 Assessment





### **CDE Level 4 -** Refined Assessment

- Finalizes the process of collateral damage mitigation
- Serves as the transition between measuring collateral damage and estimating civilian and noncombatant casualties in CDE Level 5
- Based upon two assumptions:
  - Noncombatant personnel probably will seek cover inside collateral structures, reducing their exposure to weapons' effects
  - Collateral structures will shield the noncombatants from the primary warhead effects of fragmentation and debris, so long as the warhead uses a delay fuse
- Dominant hazard is blast versus the structure, leading to blunt trauma
- Requires less than 1% structural damage to the collateral structure







### **CDE Table 4A**

- Provides average values for each warhead versus an known collateral structure type
- Grades the listed structures based on resistance to blast
- In addition, given the propensity for weapons to impact long of the target, a stated delivery heading restriction is required within CDE Level 4 for PGMs
- Requires warhead burial or detonation in a structure
- The tactical restriction for execution to a specific warhead, or one with a smaller EMD, delivered with a delay fuse setting, and restricted to a specified delivery heading elevates the risk to the mission







CDE Level 4		
Assess and record collateral structure types		
Select and enter CDE Level 4 weaponeering solution		
Is the CDE Level 4 EMD for the weaponeering solution less than the distance calculated in CDE Level 3?	Yes	No
CDE Level 4 Assessment	Low	High
Delivery Heading Restrictions		
Other mitigation techniques		







CDE Level 4		
Assess and record collateral structure types		
Select and enter CDE Level 4 weaponeering solution		
Is the CDE Level 4 EMD for the weaponeering solution less than the distance calculated in CDE Level 3?	Yes	No
CDE Level 4 Assessment	Low	High
Delivery Heading Restrictions		
Other mitigation techniques		

Assess as CDE Level 4 Low Use chosen weapon/ fuse/heading Use any other mitigation techniques

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### **CDE Level 4**

CDE Level 4		
Assess and record collateral structure types		
Select and enter CDE Level 4 weaponeering solution		
Is the CDE Level 4 EMD for the weaponeering solution less than the distance calculated in CDE Level 3?	Yes	No
CDE Level 4 Assessment	Low	High
Delivery Heading Restrictions		
Other mitigation techniques		

Assess as CDE Level 4 High Conduct CDE Level 5 Assessment



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### Collateral Damage Mitigation

- CDM considers five mitigation techniques
  - Delay fuse / warhead burial
    - Mitigates fragmentation hazard
    - Creates debris hazard (Remember CDE Level 3?)
  - Variable Time (VT) / Proximity Fuse
    - Mitigates blast effects and damage to structures (Remember CDE Level 4 assumptions?)
    - Increases fragmentation hazard
  - Delivery heading restrictions
    - Warheads generally impact long, regardless of delivery method (Built into CDE Level 4)
  - Shielding
    - Limited to what is on the ground, but consider it between CDE Levels 4 and 5
  - Aimpoint Offset
    - Limited to what is on the ground, but consider it between CDE Levels 4 and 5



### CDE Level 5 - Casualty Assessment

- Only level within the methodology where a final CDE High assessment may be rendered
- At this point, all known reasonable mitigation techniques have been employed and collateral damage cannot be avoided
- Not an exact science
- Produces an estimation that allows the commander to reasonably determine if authority exists, under the ROE, to approve application of effects on the target
- The primary decision aid to determine this authority is the noncombatant casualty cut-off value (NCV)
- The NCV for a specific operations normally is stated in the ROE







Assess collateral concern functionality from Population Density Table and record on Cas Estimation Worksheet (CEW)	the sualty		
Compute affected sq ft and record on CEW	8		
Select population density for day, night, and episodic and record on CEW			
Determine casualty factor and record on CEW			
	Day:		
Compute the casualty estimate, adding any DTRA or AFMIC casualty estimates	Night:		
,	Episodic:		
Is the computed casualty estimate less than the NCV?	Yes	No	
Assessment	Low	High	





CDE Level 5

Assess collateral concern functionality from the Population Density Table and record on Casualty Estimation Worksheet (CEW)

Compute affected sq ft and record on CEW

Select population density for day, night, and episodic and record on CEW

Determine casualty factor and record on CEW

Compute the casualty estimate, adding any DTRA or AFMIC casualty estimates	Day:	
	Night:	
	Episodic:	
Is the computed casualty estimate less than the NCV?	Yes	No
Assessment	Low	High

Assess as CDE Level 5 Low Use chosen weapon/ fuse/heading Use any other mitigation techniques Record Casualty Estimate (Still going

to have collateral casualties!)





CDE Level 5

Assess collateral concern functionality from the Population Density Table and record on Casualty Estimation Worksheet (CEW)

Compute affected sq ft and record on CEW

Select population density for day, night, and episodic and record on CEW

Determine casualty factor and record on CEW

Compute the casualty estimate, adding any DTRA or AFMIC casualty estimates	Day:	
	Night:	
	Episodic:	
Is the computed casualty estimate less than the NCV?	Yes	No
Assessment	Low	High

Assess as CDE Level 5 High Use chosen weapon/ fuse/heading Use any other mitigation techniques **Record Casualty** Estimate Seek Elevated **Approval Authority**  FOUO



### CDE Level 5 Population Density Reference Table

- Provides a standardized format to assist in developing casualty estimation demographic reference tables specific to a region or country
- Demographic data is stated as population per 1000 square feet for each of the listed collateral concern functionalities
- Day and night factors are based on socialized cultural norms for daytime and nighttime functional activities
- Episodic event factors are based on standard maximum population densities per 1000 square feet for the events described within the table







### CDE Level 5 Casualty Estimation Worksheet

- Provides a standardized means to compute casualty estimates
- A final casualty estimate is based on the affected area of a collateral concern divided by 1000 square feet, multiplied by the casualty factor, and then multiplied by the population density per 1000 square feet
- The population density is taken from the region or country-specific CDE Level 5 Population Density Reference Table for the appropriate time of day and collateral concern functionality.
- The casualty factor is based on the type of collateral concern, such as indoor, outdoor, or dual-use
- The result is rounded to the next whole number
- Targets characterized as having both a military and civilian purpose/function are characterized as dual-use

