A Fascinating Future-History Simulation Game

the time is: Tomorrow

Jaws of the Dragon

Modern War in the Pacific

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EVAN 2000

Rulebook

Jaws of the Dragon Rulebook

Powered By Evan's Wargaming Operational Kampaign System (EWOKS) v5.2
Semi-Rigid Kreigspiell Rules Written by Evan D'Alessandro © 2024[1]

Assumptions

1 turn = 1 day
1 hex (Operations Map) = 100 miles, which is 161 km or 87 nm
1 hex (Taiwan Map) = ~ 1/6th of a hex on the Operations map = ~ 17 miles = 30 km

Unit	Constituent Units	Missiles[2]	Notes
CSG	1 carrier + 4-5 ships[3]	2 Atk., 6 Def. 7/13 Sqdn. Strikes	~400 VLS cells. NOTE: Subs for the purposes of this are not included as part of a CSG counter. US Carriers, 13 squadron strikes worth of munitions, other carriers 7 squadron strikes[4]
ESG	2 amphib + 4-5 ships	2 Atk., 6 Def.	1 embarked marine bn. landing team. ~400 VLS cells.
SAG	4-5 ships	3 Atk., 5 Def.	Roughly 400 VLS cells.
Missile Boats	6 Missile Boats[5]	1 Atk.	Any sort of ships using hit and run tactics (incl. corvettes, frigates)
Nuke Sub	1 submarine	1 Atk. (Seawolf)	US subs (LA, Virginia) tend to have 12 LACM, Seawolfs carry 50 torpedoes/LACM
Diesel Sub	1 submarine		
SSGN	1 submarine	6 Atk. (LACM)	
Land Units	Brigade Size		Logistics, air defense, etc. abstracted. While frontages are quite wide here 4 units per hex would allow for a "continuous line" to be formed.[6]
MLR/MDTF	N/A	1 Atk.	For missile numbers see endnote[7]
Air Units	Squadron		Tankers, AWAC's, BACN, EW, SEAD (generally), drones, etc. abstracted, **but assumed to happen as/be a part of operations**. 12 x 5th Gen aircraft, 16-18 all other gens per sqdn.
Bombers	US 6, Chi. Regiment		# based around 100 missiles, B-1's can carry 24, B-52's 20, B-2's 16, HK-6's can carry 6 YJ-12

Movement

Unit	Movement	Notes
CSG, ESG, SAG, Missile Boat	6 hexes/day	Assuming speed of 25 knots.
Submarines	3/6* hexes/day	*Nukes can sprint 6, but more detectable (diesels may not sprint). Normal slow speed + need to get coms limits stealthy movement.[8]
Land Units (Rotating)*	0 [1] hexes/day	
Land Units (Cross Country)*	1 [5] hexes/day	
Land Units (Road)*	2 [11] hexes/day	TRADOC Pamphlet 350-14, September 1994, Heavy Opposing Force (OPFOR) Operation Art Handbook[9]
Land Units (Rail)*	5 [27] hexes/day	TRADOC Pamphlet 350-14, September 1994, Heavy Opposing Force (OPFOR) Operation Art Handbook[10]
(Dis)Embark Brigade on Ships	Load ½ Brig/day/port	Assumes simultaneous loading of all ships for the brigade, and that ships are ideal ships for such use[11]
Squadron changing Air Sectors	2 (US) / 3 days	Represents teeth element deployment, followed by supporting elements.[12]

Numbers in [#], are the numbers for use on the Taiwan map with its smaller hexes.

Weather[13]

Represents predominate weather conditions for each Air Sector.

Clear

- No Effects.

Rain/Heavy Clouds

- Tracking rolls have -2, all Air Strikes have a 30% chance to Abort.
- Sub detection -1

Storms

- Tracking rolls have -4, all Air Strikes abort.
- Missile boats may not attack.
- -1 Colum shift on Attack
- Sub detection -4
- No anphib/air assaults

Detection / Tracking (d10)[14]

Approximate locations of units in hexes are always known, sea units can only be engaged however if they are tracked.

Surface Ships (task force):

- If inside the First Island Chain, on a d10 roll the # of hexes or higher to the nearest friendly country or carrier to track.
- If outside the First Island Chain, roll a d10. On a 9 or 10 they are tracked. +1 if the target is a carrier conducting flight operations.[15]
- If ships are in the same hex they are tracked.[16]
- Carriers may use a squadron to detect a hex in range
- Ships in port are always tracked.
- Ships defending a beachhead are always detected.

Submarines

- See the detection section of Undersea Combat.

Land Units and *Air Units* are always tracked.[17] Exception: MDTF's and MLR's must be tracked to be engaged by rolling a 9+.[18]

Sea Movement

Unit	Movement	Notes
CSG, ESG, SAG	6 hexes/day	
Submarines (Nuke)	3/6 hexes/day	May sprint up to 6, but more detectable.
Submarines (Diesel)	3 hexes/day	If not moving may bottom sit (not move) to decrease detectability.

Aircraft Carriers Munitions Storage

Carrier	*Squadron Strikes of Munitions**
US Carriers	13
All Others	7

*1 strike by 1 squadron consumes 1 squadron strike of munitions *(read that 5 times fast!)*.

Munitions and VLS can be fully refilled by spending 1 day in port.

Sea Combat (d10)[19]

Missile Ranges (***MUST HAVE DETECTED ENEMY TO SHOOT***)

Important Info		*Unimportant Info*	
Missile Type	**Range**	***Missiles Attacking***	***Notes***
Chinese AShM	2⬢		*95 missiles/salvo. Assumed to be either YJ-12 (supersonic) or YJ-91 (sea skimming, supersonic), average range is about 200mi (2 hexes).*
Chinese Missle Boat	1⬢		*Assuming YJ-83 (max. 150 mi range), less range due to sea state or lower onboard targeting ability.*
US AShM	1⬢		*115 missiles/salvo Assumed to be sea skimming. Either SM-2, SLAM-ER, Naval Strike Missile or Harpoon.[20]*
Sub AShM	1⬢		*# of missiles/salvo is dependent on nation. Have to have better targeting so must be in same hex.*
C Carrier J15	4⬢ (3⬢+1⬢)	**1 Atk[21]**	*J-15 combat radius is 647 nautical miles, though at full combat load launching from a carrier it's going to be shorter due to the weight restrictions of the STOBAR system of Chinese Carriers.[22] (3⬢) firing YJ-83 (NOT YJ-12), so +1 hex of range.*
US Carrier F-18	6⬢ (5⬢+1⬢)	**1 Atk.**	*F-18 combat radius w/ drop tanks is ~450 nautical miles (5⬢).[23] Firing US ASHM, see note above.*
US Carrier F-35	6/8⬢ (6⬢+2⬢)	**8 w/ LRASM Salvo Only**	*F-35 combat radius is 1000km[24](600mi) (7⬢). Firing US ASHM, see note above.*
Chinese LACM	18⬢		*? missiles/salvo, ~30. Based on CJ-10 Range[25]*
US LACM	10⬢		*30ish missiles/salvo. Based on Block IV/V Tomahawk (900 nm range)[26]*

Roll type = Offensive missiles – ½ Defensive missiles* *(e.g. 2 defensive missiles cover 1 offensive)*[27]

D10 Roll[28]	- 1 -	- 2 -	- 3 -	- 4 -	- 5 -	- 6 -	- 7 -	- 8 -	- 9 -	- 10 -
If Defense greater	–	–	–	–	–	–	–	–	*1 Damage*	*1 Damage*
If Defense is equal	–	–	–	–	*1 Damage*	*1 Damage*	*1 Damage*	*1 Damage*	*2 Damage*	*2 Damage*
If Defense less than	*1 Damage*	*1 Damage*	*2 Damage*	*2 Damage*	*3 Damage*	*3 Damage*	*3 Damage*	*3 Damage*	*3 Damage*	*3 Damage*

Excess damage carries over to other units in the same task force.

Type	**1st Damage**	**2nd Damage[29]**	**3rd Damage[30]**
SAG	• Loose half (1/2) missiles • ASW effectiveness decreased.	Sunk[31]	-
CSG (Carrier)	• Loose half (1/2) missiles	• Lose remaining missiles • Speed one-half (1/2) • Half (1/2) sortie generation • ASW effectiveness decreased.	Sunk
ESG (Amphib)	• Loose half (1/2) missiles • Carried units ¼ damaged	• Lose remaining missiles • Speed one-half (1/2) • Carried units ½ damaged • ASW effectiveness decreased	Sunk
Missile Boat Squadron	• None	Sunk	-

Submarine Combat (d20)[32]

Movement

Submarines may opt not to move but instead remain in place. Doing so they do not move but rather they gain movement that they can use on later turns. Turn them 90˚ to mark 1 turn of unused movement, and 180˚ 2 turns of unused movement. A sub may never store more than 2 turns of movement. When the submarine opts to move it can move using stored movement. However, if the sub moves into a hex where it might be detected, it must stop and end its movement there. If a sub with stored movement has detection attempts made against it, it immediately loses all stored movement and remains in the hex it was in.[33]

Using the Detection Table

- The sub attempts to attack, provides cuing for a strike by long range fires, or shadows a unit.
  - Use below table.
- For each enemy unit with detection capabilities (Sub, CSG, ESG, SAG) the sub is in the same hex as, or if the sub launches a long-range missile attack.
  - Roll a d20: on a 1 the sub has been detected.
- The sub is in a hex that MPA's are operating in in number (umpire discretion).
  - Use table column below for *ASW Fixed Wing.*[34]
- The Sub is in a hex with an enemy port.
  - Use table column below for *ASW Rotary.*

Detection

Roll higher than or equal to the number on D20 to detect the target. Modifiers (advantage/disadvantage[A]):

- Sub is sprinting – advantage to detect sub.[35]
- Ship moved more than 3 hexes – disadvantage for ships detecting.[36]
- Searching unit is damaged – disadvantage for damaged units.
- SSK is bottom sitting – disadvantage to detect SSK.[37] (assume bottom sitting if the diesel did not move this turn and is in shallow water)

Water Depth[38]
- Shallow Water = –3
- Medium/Deep Water = +0

Weather Effect[39]
- Rain/Clouds = -1
- Storms = -3

(Note that rolling twice on a d20 is approximately equivalent to +/-3.3)

ASW Table (d20)[40]

	US/Allies			Chinese*			Platforms		
Hunter ▶ Hunted ▼	**Sub**	**SAG or ESG**	**CSG[41]**	**Nuke Sub**	**Diesel Sub**	**SAG ESG CSG**	**Counter fire**	**ASW Fixed Wing (1✈)[42]**	**ASW Rotary**
Seawolf	-	-	-	18	16	18	17	20	19
Virginia	-	-	-	17	15	18	16	20	19
Los Ange	-	-	-	15	14	17	12	20	18
CType93	6	11	10	-	-	-	7	20	16
C Diesel	5	11	8	-	-	-	7	19	16
C SSBN	6	11	10	-	-	-	7	20	16
Japan	-	-	-	16	15	18	10	20	17

US hydrophones detect on 7+ in the hex they are in[43]
* If inside Chinese hydrophone line add +1

May attacked detected target.

Attack Table (only use if sub is detected)[44]

- *The sub that rolled the higher number to detect attacks first. - if both detected, the attacker then counterfires*
- If sub is defending a *moving* surface target, the defending sub must be engaged first before the surface target can be engaged, unless attacker is bottom sitting.[45] (only SSN's may defend moving targets this manner)[46]
- For Subs vs. Subs *and* ASW vs. Subs. If sub shoots at another sub that had not detected the attacker, use Counterfire to see if shooting sub is detected, and the attacked sub can fire in response.

D20 Roll	**1 to 10**	**11 to 20**
Atk. vs. Subs	*Sub Escapes, may not attack again this turn.*	*Sub Sunk*
Atk. vs. Surface	*No effect*	*1 Damage Caused to Surface Group*[47]

[A] Advantage = roll a second die and use the higher number. Disadvantage = roll a second die and use the lower number.

Air Movement

Unit	Movement	Notes
Squadron Switching Sectors (US)	2 days[48]	Represents teeth element deployment, followed by supporting elements. REQUIRES TANKERS OR BUDDY TANKING IF NOT CHINESE[49]
Squadron Switching Sectors	3 days[50]	
Taiwanese Aircraft Dispersal	0 days	Dispersal of aircraft to civilian airports, highway sites, etc.[51]

Air Combat (d10)[52]

Carrier Air uses a range system rather than sector system, see Sea Combat for details.

Squadrons[53] can take 2 attrition[54] before being destroyed (e.g. on the 3rd attrition result it is destroyed).

Teeth Aircraft	*Support Aircraft*

Squadrons can be used to conduct one of the following missions[55] per turn in their or an adjacent Air Sector:[56]
• **Fight for Air Supremacy**[57] – All squadrons dedicated to fighting for air supremacy are paired up at random with Enemies and then roll on the Air-to-Air Table for resolution.
  ○ Squadrons that are unpaired 1:1 can be reassigned or can gang up in other fights (max 3:1, or if stealth 2:1)
• **Intercept Strikes**[58] – Can attack one strike and its escorts (EXCEPTION: Carrier air may intercept all strikes on their carrier[59]). Battles any escorting fighters as if Fighting for Air Supremacy. A maximum of 3 squadrons can engage each enemy squadron.[60]
  ○ vs. Escorted - If the Interceptors inflict a Damaged or Destroyed result on the escorting Squadron, roll on the Escorted Strike row.
  ○ vs. Unescorted – roll on the Unescorted Strike row.
• **Escort Strike**[61] – Select a strike to Escort. If strike is attacked, squadron battles intercepting fighters as if Fighting for Air Supremacy.
• **Conduct Strike**[62] – A squadron may conduct a strike on any unit in its air sector.
  ○ Maritime Strike – Attacking enemy naval unit(s). Air strikes carry 1 missile per squadron (or 2 per bomber flight).
  ○ Air Support[63] – if Strike makes it through, notify Land control.
  ▪ Ground Support – deal 1d2 attrition (or 1 if squadron is damaged) to a targeted ground unit.[64]
  ▪ Interdiction - The squadron inflicts 1 attrition on an enemy unit moving and reduces their movement by half.
  ○ Ports/Air Bases – Roll on tables in the Missile Rules.
• **SEAD**[65] – A squadron equipped to conduct a SEAD missions degrades IADS by 1 for one strike.
	Support Squadron – 1 required per Air Sector to avoid *No AWACS* penalty.
	
	MPA – If air superiority in Air Sector, generates 2 ASW sweep tokens to be placed by Naval Control in that sector (each has a 5% chance to detect subs)
	
	Tankers
	• Allows 2 squadrons to conduct operations in adjacent areas
	• Allows 1 bomber sortie from offmap bases (or 2 Tanker sqdn. required if flying from CONUS).
	• Allows 1 squadron to move to a different sector.

IADS[66]

For any enemy squadron operating in a sector with an IADS value, roll a d10. If the number is less than or equal to the IADS value, the squadron is damaged. *Exceptions*:

- Aircraft using standoff munitions for a strike reduce IADS value by 1.
- 5th Gen aircraft reduce IADS value by 1 against them, and B-2's reduce it by 2.[67]
- When ground attack aircraft conduct a strike, they add 1 to IADS value (even if IADS value is 0).[68]

Air-to-Air Table[69]

Roll = d10 roll + Attackers attack modifier, + Defender defense modifier.

When a squadron has 2 attrition it rolls two d10 and uses the worse result.

D10 Roll	- 1 -	- 2 -	- 3 -	- 4 -	- 5 -	- 6 -	- 7 -	- 8 -	- 9 -	- 10 -	- 11+ -
Air-to-Air	–	–	–	–	–	–	–	☠	☠	☠	☠☠
Escorted Strike*	↩☠	↩	☠	☠	–	–	–	–	–	–	–
Unescorted Strike	↩☠☠	↩☠	↩☠	↩☠	↩☠	↩☠	↩☠	☠	☠	–	–

☠ = Strike damaged, ↩ = Strike aborts

*If multirole conducing a strike are intercepted, they count as a *escorted strike* even if they lack a escort.[70]

Modifiers[71]

	5th Gn	4th Gn	3rd Gn	F-35 Support	4th Gn vs 5th Gn	No AWACS
Attack Mod.	+1	+0	-1	+1 to friendly sqdn. attacking same target in the air engagement 1/turn.[72]	+1 to 4th Gn.[73]	-2
Defense Mod.	-3	+0	+1			

Land Movement

Unit	Movement (Op Map)[74]	Movement (Taiwan Map)	Notes
Land Units (Rotating)	0 hexes/day	1 hexes/day	
Land Units (Cross Country)	1 hexes/day	5 hexes/day	
Land Units (Road)	2 hexes/day	11 hexes/day	TRADOC Pamphlet 350-14, September 1994, Heavy Opposing Force (OPFOR) Operation Art Handbook
Land Units (Rail)	5 hexes/day	27 hexes/day	TRADOC Pamphlet 350-14, September 1994, Heavy Opposing Force (OPFOR) Operation Art Handbook
Helicopter Unit (Assault/Reposition)	3 hexes/day	16 hexes/day	Guess, reposition assumes viability of logistics at new location
(Dis)Embark Brigade on Ships	Load ½ Brig/day/port		Assumes simultaneous loading of all ships for the brigade, and that ships are good ships for such use[75]

Land Combat (d4)[76]

Land units can take points of damage up to their combat power.[77] Every 20 attrition[78] = 1 point of damage. 1 point of attrition can be removed every 2 days by rotating the unit off the front line (artillery/helicopters do not regenerate).[79] Each point of damage subtracts 1 from the unit's combat power. A unit with no combat power remaining is destroyed.[80]

Procedure:

- Pick units to attack, each unit only engages 1 unit in the hex.
- Determine Combat
  - Ratio Column = Sum Attacker Power vs. Sum Defender Power
    - Unsupplied units halve combat power[81]
  - Note any column shifts from other factors
  - Then roll 1d4[82] for each side and shift that number of columns in each side's favor
- If a unit forces a retreat, it can attack another enemy in the sector at 1 unfavorable column shift.

Attritional vs. Maneuver Combat[83]

When attacking decide if the attack is an attritional attack or maneuver attack. Attritional attacks resolve as normal on the table below. If the attack is a maneuver attack however, when a result states that the unit was attritted, it takes d6 attrition (exploding dice, 5 or 6)[B] instead of just one, and the other side takes the same amount -1.[84] All other attacking units involved in the maneuver combat take 1 attrition.[85] Helicopter units take 3x normal attrition, artillery 2x.[86]

Ratio = Sum Attacker Power vs. Sum Defender Power
Then roll 1d4 (if Maneuver), or don't (Attrition)[87] for each side and shift that # of columns in each side's favor.

Atk vs. Def Ratio:[88]	1:4	1:3	1:2	1:1	2:1	3:1	4:1	5:1	6:1	7:1	8:1	9:1	10:1	11:1
Meeting Engagement	▲ ⚐	▲	☠	☠	☠	⛊	⛊	⛊	⛊	⛊ ⚐	⛊ ⚐	⛊ ⚐	⛊ ⚐⚐	⛊ ↪ ⚐⚐
Preped Atk. vs. Preped Def	▲	▲	▲	▲	☠	☠	⛊	⛊	⛊	⛊	⛊ ⚐	⛊ ⚐	⛊ ⚐	⛊ ↪ ⚐
Prepared Atk. vs. Breaching	▲▲ ⚐	▲▲ ⚐	▲▲	▲▲	▲▲	▲	☠	☠	⛊	⛊	⛊	⛊	⛊	⛊ ⚐

▲ = Attacker attritted, ⛊ = Defender attritted, ☠ = Attacker and Defender attritted
↪ = Number of hexes damaged unit must retreat (cannot be mitigated). If unit cannot retreat to friendly hex it is destroyed.
⚐ = Number of hexes damaged unit must retreat. A unit can choose not to retreat (or to retreat some) and is attritted for each ⚐ it chooses to ignore.[89] If unit must retreat and cannot retreat to friendly hex it is destroyed.

Factors	Column Shift	Other Effects
Light Infantry vs. Armor[90]	1 favorable shift for Armor	
Air Support (per strike)[91]	1 favorable shift	
Light Urban/Rice Paddies/Hills (Rough)	1 favorable shifts for Defender[92]	
Mountains/Heavy Urban (Very Rough)	3 favorable shifts for Defender[93]	May ignore 1 ⚐.
Fortification (per lvl., max 2)[94]	1 favorable shift for Defender[95]	May ignore 1 ⚐ per fortification, Attacker takes 2x casualties.[96]
River Crossing[97]	1 unfavorable shift	Double the attrition.
Amphibious Assault	2 favorable shifts for Defender[98]	Triple attrition.
Air Assault	Unit takes losses equal to IADS Value + 1d4 x 10%[99]	
Naval Gunfire Support[100]	1 favorable shift	
Unit can't do Brig. lvl. combined arms*	1 unfavorable shift *when attacking*[101]	
Surprise + Successful Deception[102]	4 favorable shifts *when attacking*	Defender takes 5x attrition

* This applies to Taiwanese C-Level reserve units, and to PLA units during amphibious attack

[B] E.g. if a 5 or 6 is rolled on the dice, roll again and add that to the total, if another 5 or 6 is rolled, roll again and add to the total, and so on…

Tactical Nuke Rules

Naval Units (1 Nuke): Units may intercept incoming salvos, then roll a d10 for each nuke: [1-6] No damage, [7-10] Unit damaged.[103]

Naval Units (Multiple Nukes): Units may intercept incoming salvos, then roll a d10 for each nuke: [1-6] No damage, [7-10] Unit damaged.

Air Units: the unit is destroyed. [104]

Ground Units: If unit is a Battalion the unit's dispersion determines damage:[105]

Dispersion	**Example**	**Damage[106]**
Highly Dispersed	Defending an area after dispersing due to nuclear threat.	10%
Dispersed	Defending an area.	30%
Concentrated	Conducting an attack.	40%
Highly Concentrated	Defending a key point (airfield, port), fighting in urban terrain.[107]	80%

Pre-Generated Damage Reference[108]

Unit Cbt. Power	Damage			
	10%	30%	40%	80%
1	0 Damage, 1 Attrition	0 Damage, 2 Attrition	0 Damage, 2 Attrition	0 Damage, 4 Attrition
1.5	0 Damage, 1 Attrition	0 Damage, 3 Attrition	0 Damage, 3 Attrition	1 Damage, 1 Attrition
2	0 Damage, 1 Attrition	0 Damage, 3 Attrition	0 Damage, 4 Attrition	1 Damage, 3 Attrition
2.5	0 Damage, 2 Attrition	0 Damage, 4 Attrition	1 Damage, 0 Attrition	2 Damage, 0 Attrition
3	0 Damage, 2 Attrition	1 Damage, 0 Attrition	1 Damage, 1 Attrition	2 Damage, 2 Attrition
3.5	0 Damage, 2 Attrition	1 Damage, 1 Attrition	1 Damage, 2 Attrition	2 Damage, 4 Attrition
4	0 Damage, 2 Attrition	1 Damage, 1 Attrition	1 Damage, 3 Attrition	3 Damage, 1 Attrition
4.5	0 Damage, 3 Attrition	1 Damage, 2 Attrition	1 Damage, 4 Attrition	3 Damage, 3 Attrition
5	0 Damage, 3 Attrition	1 Damage, 3 Attrition	2 Damage, 0 Attrition	4 Damage, 0 Attrition
5.5	0 Damage, 3 Attrition	1 Damage, 4 Attrition	2 Damage, 1 Attrition	4 Damage, 2 Attrition
6	0 Damage, 3 Attrition	1 Damage, 4 Attrition	2 Damage, 2 Attrition	4 Damage, 4 Attrition
6.5	0 Damage, 4 Attrition	2 Damage, 0 Attrition	2 Damage, 3 Attrition	5 Damage, 1 Attrition
7	0 Damage, 4 Attrition	2 Damage, 1 Attrition	2 Damage, 4 Attrition	5 Damage, 3 Attrition
7.5	0 Damage, 4 Attrition	2 Damage, 2 Attrition	3 Damage, 0 Attrition	6 Damage, 0 Attrition
8	0 Damage, 4 Attrition	2 Damage, 2 Attrition	3 Damage, 1 Attrition	6 Damage, 2 Attrition
8.5	1 Damage, 0 Attrition	2 Damage, 3 Attrition	3 Damage, 2 Attrition	6 Damage, 4 Attrition
9	1 Damage, 0 Attrition	2 Damage, 4 Attrition	3 Damage, 3 Attrition	7 Damage, 1 Attrition
9.5	1 Damage, 0 Attrition	3 Damage, 0 Attrition	3 Damage, 4 Attrition	7 Damage, 3 Attrition
10	1 Damage, 0 Attrition	3 Damage, 0 Attrition	4 Damage, 0 Attrition	8 Damage, 0 Attrition
10.5	1 Damage, 1 Attrition	3 Damage, 1 Attrition	4 Damage, 1 Attrition	8 Damage, 2 Attrition
11	1 Damage, 1 Attrition	3 Damage, 2 Attrition	4 Damage, 2 Attrition	8 Damage, 4 Attrition

Missile Rules (d10)

- If over ½ range <u>targeting Ships</u> (e.g. moving targets), each salvo counts as ½ of a salvo (excluding hypersonics), if DF-26 at extreme range, each salvo counters as 1/3rd.[109]
- Aircraft attacks on airbases or ports count as 2+ salvos vs. Airbases, and a single salvo vs Ports.

- **AShM** – roll on Sea Combat damage table (Land Attack missiles may attack ships in port, AShM may not[110]). NOTE <u>each missile salvo of this type can be covered to parity by 1 defensive missile.</u>
- **Ground Targets** – Inflict 1 attrition. In exceptional circumstances, may instead be a 1 column shift.[111]
- **IADS** – Roll a D10 and subtract the IADS value of the selected air zone, add 3 if the missiles are hypersonic or stealthy. On a 7+ IADS is reduced by 1 in the selected air zone for one turn.

Vs. Airbases and Ports[112]

Reduce the functional number of salvos by 1 for:[113]

- Each THADD battery defending.
- Each squadron on Intercept Strikes at the area (vs. cruise missiles only).
- If the missiles are Stealthy or Hypersonic, <u>ignore one THADD battery or Squadron</u>.[114]

Airbase

D10 Roll[115]		- 1 -	- 2 -	- 3 -	- 4 -	- 5 -	- 6 -	- 7 -	- 8 -	- 9 -	- 10 -	
Single Salvo	Attrition	–	–	–	–	–	–	1 x ☠ -parking	1 x ☠ -parking	2 x ☠ -parking	2 x ☠ -parking	Cluster Munition + no HAS = +1[116]
	Airbase Closed	–	–	–	–	–	–	–	–	1	d2	+1 if Bunker Buster[117]
2+ Salvos	Attrition (per salvo)	–	1 x ☠ -parking	1 x ☠ -parking	2 x ☠ -parking	2 x ☠ -parking	2 x ☠ -parking	2 x ☠ -parking	2 x ☠ -parking	2 x ☠ -parking	3 x ☠ -parking	Cluster Munition + no HAS = +1
	Airbase Closed	–	–	–	1+	1+	d2+	d3+	d4+	d6+	d10+	+1 if Bunker Buster

x ☠ -parking = Inflict that number of attrition to aircraft at the base. Subtract the number of unused squadrons[118] of parking at the base from the total attrition <u>(sum of all salvos).</u>[119] – Civilian dispersal airports count as having 3 unused space.

Airbase Closed (#) = Airbase and runway inoperable for that number of days. For each salvo over two, add 1 day for the 3rd salvo, and 2 days for each subsequent one (4th salvo onward):

Salvo	3rd Salvo	4th Salvo	5th Salvo	6th Salvo	7th Onward
Extra <u>Cumulative</u> Days of Closure	1	3	5	7	+2 etc.

If target is a dispersed airfield or civilian airfield, triple the closure time (max 21 days).

Ports[120]

D10 Roll		- 1 -	- 2 -	- 3 -	- 4 -	- 5 -	- 6 -	- 7 -	- 8 -	- 9 -	- 10 -
Single Salvo	Port Closed	–	–	–	–	–	–	–	1	1	d2
2+ Salvos	Port Closed (1 roll per salvo)	–	–	1	1	d2	d2	d3	d3	d4	d4

Port Closed (#) = Roll the dice in the brackets to determine how many days the port is not functional.

(If detail is needed on a 5+ per salvo each of the following is damaged: drydock, fuel farm, munitions storage.)

Mine Rules (d10)[121]

Minefields are placed at specific locations. These can either open water, or on specific landing beaches/ports.

Clearing Minefields

Each minesweeping ship is allocated to clear a minefield, it clears d6 mines per day.[122] Each day there is a 1% chance of each minesweeper being sunk by a mine.[123] Clearing an entire minefield require sweeping all the mines, but clearing a lane requires clearing 10% of the mines.[124] Clearing a *maneuver zone for firepower support ships*, also requires clearing 10% of the mines, failure to clear prevents naval gunfire support.[125]

SOF Rules (d20, d10)

Missions	*Adjudication*
Battlefield Surveillance and Reconnaissance[126]	50% (6+) chance to Detect and Track one enemy ground unit in the given hex, or all air or naval units at a given base.
Direct Action against Point Target	40% (7+) chance of 1 attrition to an enemy unit OR 10% chance (10+) of damaging enemy naval unit
Airfield Attack	30% chance (8+) of 1d6-3 damage against a squadron.[127]
Attacks against Enemy Logistics[128]	20% (9+) chance of enemy loosing 1 supply at random.
Brigade Support[129]	10% (10+) chance of a favorable column shift on the Attack/Defense
Degrade IADS	30% (8+) chance of decrease IADS for one strike.

After the mission: Roll a d20, on a 1 the unit is destroyed. Otherwise, the card is given back to the team in d10 turns.

Endnotes

[1] The Author wishes to thank RC and Maj. Tom Mouat for offering their help in checking these rules.

Jan 5th, crossed 30,000 words in footnotes

[2] 1/3 of missiles on a US destroyer are offensive missiles in peacetime, thus with 8 missile cubes of 50 missiles each this is 3/5. Players could of course opt to change the inventory of their reinforcement units who would have the time to change their loadouts as they see fit. Ships at sea are stuck with their loadouts, though depending on the scenario the side with the initiative may opt to change their loadouts, while the side lacking initiative would not be able to. For the 1/3 number see *Commanding The Seas - The U.S. Navy And The Future Of Surface Warfare* by Brian Clark from the Center for Strategic and Budgetary Assessment (2017) https://csbaonline.org/uploads/documents/CSBA6292-Surface_Warfare_REPRINT_WEB.pdf pg. 16. Of course this is somewhat complicated by the fact that certain missiles (SM-6 for example) are dual use, and land attack weapons are often different from anti-ship weapons, but this abstraction is made for simplicity.

[3] While CSG's do not always deploy with enough ships to provide 400 VLS cells of capacity, I make the assumption for two reasons: First: I suspect that in a war there would be a tendency to want to provide more magazine depth and sensor coverage than can be provided by a 3 ship configuration (1 Ticonderoga, and 2 60-cell variant Arleigh Burke for example) to defend more vulnerable assets (see *Carrier Killer: China's Anti-Ship Ballistic Missiles and Theater of Operations in the Early 21st Century* by Gerry Doyle and Blake Herzinger, pg. 33), without leading to over centralization making targeting easier (the current game system allows such stacking at the player's discretion which would make detection easier for the enemy). This makes it a player choice, not a designer choice on the value of concentration vs. dispersion of forces. Second: it limits the number of pieces on the board, making the game easier to play. Thus, all naval units (CSG, ESG, SAG) use the 400 VLS cell number as their benchmark. Note that this generally means 4-5 escorts, it may include more/less depending on the available number of VLS cells of ships and could be conceived to include additional elements like coast guard ships, USV's, or maritime militia ships. Of course this leads to problems in the external validity of the game when ships operate individually, opening themselves up to much small numbers of missiles (for example a shore-based battery) than they would if defended by others in the same group, but for ease of play and time required to play a turn this is a sacrifice I view as having low consequence on the game as a whole.

Also assumed is am oiler with the group and resupply as necessary so that cruising range is not a limiting factor

[4] With 2 full loads of ammunition the carrier supported 771 strike sorties of 1,336 total "bombs" (*The Carrier Myth*, Rebecca Grant, March 1, 1999, https://www.airandspaceforces.com/article/0399carrier/). As a first order approximation, a carrier carries 668 munitions onboard (1,336/2). Each aircraft strike in these rules is 50 munitions (~4 munitions per aircraft for a carrier squadron of 12). Thus, the carrier has 13 strikes before it has emptied its magazines. Other aircraft carriers are halved as they only have half the strike aircraft of a US carrier. Munitions are the limiting factor here as each carrier has enough aviation fuel to sustain 16 days of round the clock aviation operations (CGSC Student Text 100-3 *Battle Book*, 1 July 2000, Section 12-7).

[5] The number of missile boats making up a squadron is taken from historical numbers of ships involved in Battle of Baltim (6 Israeli, 4 Egyptian), Battle of Latakia (5 Israeli, 4 Syrian), Second Battle of Latakia (various groupings of 2, 3, and 4), Operation Trident (3 Indian missile boats plus other ships). While the average of these historical numbers is 3-5, I choose to use 6 as: 1) missile defenses are better than they were historically necessitating more missiles fired, meaning more boats necessary, 2) historically smaller ships were being engaged by missile boats, necessitating less missiles than the larger combatants of the game, 3) Chinese missile boats operate in larger groups of 8 (see *This is What a Chinese Stealth Warship Looks Like on Radar*, H I Sutton, https://news.usni.org/2021/09/27/this-is-what-a-chinese-stealth-warship-looks-like-on-radar, 2021), 4) using 6 reduces the number of pieces on the board, making the game easier to play, 5) using groups of 6 tends to yield ~50 missiles per squadron, which is the number of missiles a missile cube generally represents in this game.

[6] See Ukrainian generals' comments on Brigades holding 40km lines in https://www.nationaldefensemagazine.org/articles/2022/6/15/ukraine-to-us-defense-industry-we-need-long-range-precision-weapons (2022), note that this is under the conditions of low force densities on both sides on generally open terrain. This also appears to have been the case as per this source - "the 40th Naval Infantry

Brigade's two battalions were stretched over tens of km of the front" (see https://twitter.com/RALee85/status/1596128978024079360, archived at https://archive.ph/r7v8W, 2022). Dispersion of forces due to the nature of combat in Ukraine and lack of manpower has had at least one unit holding 27 km with 4 battalions, but units are also holding more depth than previously as well (e.g. units could stretch to hold further by reducing their depth) (*Tactical Developments During the Third Year of the Russo–Ukrainian War*, Jack Watling and Nick Reynolds, February 15th, 2025, https://static.rusi.org/tactical-developments-third-year-russo-ukrainian-war-february-2205.pdf, pg. 9), also note that the ability to strike deep into the enemy rear is also forcing higher levels of dispersion than were previously done (pg. 17). This works well in the abstract and for larger hexes on the operations map, but on Taiwan 4 brigades per hex is relatively also consistent due to smaller frontages (on the Taiwan map this would mean each brigade holds a frontage of ~5km) due to the more difficult terrain. It is worth noting that in an urban environment the frontage of a brigade becomes 6-12 blocks, where 1 block is ~100m (*ATP 3-06 Urban Operations*, July 2022, section 4-42), but lines can be lengthened the lower the opponents force density is (and I am of the opinion low force densities will feature in a Taiwan invasion due to the lack of PRC units to move across the strait that can be kept supplied, and the low number (and manning) of Taiwanese units (e.g. not having forces for divisions on divisions fights coupled with the massive space of megacity/mountainous terrain)).

[7] MLR – TBD, MDTF – Mid Range Battery = 16 Tomahawk or SM-6 (https://www.thedrive.com/the-war-zone/first-land-based-tomahawk-and-sm-6-launcher-delivered-to-army, December 2022) , Long Range Hypersonic Weapon Battery = 8 missiles (https://crsreports.congress.gov/product/pdf/IF/IF11991, March 31, 2023), In the future may include more interceptors - https://www.thedrive.com/the-war-zone/usmc-buying-nearly-2000-tamir-interceptors-for-its-iron-dome-systems

[8] Sprint speed from Wikipeida for various boats (25 kt, or higher). 10 kt. Top stealth speed from conversation on genral rule of thumb from submarine engineer.

[9] As per https://upload.wikimedia.org/wikipedia/commons/8/8d/TRADOC_Pamphlet_350-14_-_Heavy_Opposing_Force%2C_OPFOR_Operational_Art_Handbook_%28September_1994%29.pdf, pg. 58 (3-3), this is a high bound (200 miles a day) but is possible. This assumes hard surface roads (reasonable as all countries here are modern countries with well-developed road infrastructure), and the given number is for divisions not brigades, brigades would likely be more efficient due to their smaller size. The source notes to add 10-20% distance for mountainous routes, which while a mild stretch, could fit within the high bound.

[10] As per https://upload.wikimedia.org/wikipedia/commons/8/8d/TRADOC_Pamphlet_350-14_-_Heavy_Opposing_Force%2C_OPFOR_Operational_Art_Handbook_%28September_1994%29.pdf, pg. 66 (3-11), gives the bound of 600-1000 km/day (including loading/unloading), so I take the middle (800km/day).

[11] SDDCTEA PAMPHLET 700-2 Logistics Handbook For Strategic Mobility Planning, Military Surface Deployment And Distribution Command, 2011, https://www.sddc.army.mil/sites/tea/functions/deployability/deployabilityanalysis/key%20publications/pam_700-2.pdf, Load/Unload times: Table 6 on pg. 56. Assumes sufficient ships are available for use.

[12] If necessary limited operations can be conducted by a squadron's teeth element operating in a very expeditionary capacity, backed by one or two cargo planes/tankers as demonstrated by US exercises in the Pacific, then allowing the rest of the squadron to flow in over several days (so operations can be conducted from the second day in a limited capacity). Alternatively, if there are already forces there, they are merely reinforcing existing squadrons and can leach off of their logistics for a short period until the squadron's own logistics and maintenance arrive. However, the main reason for this is to ease the amount of work Control has to do while running the game.

[13] **Weather**

Weather represents the predominate weather conditions in the area for that day. E.g., clear means the area is clear for most of the day or Storms mean that large storms are effecting operations in the area, not that the entire area is covered in storms.

Effects in this section is primarily based on an interview with Paul Kendal OBE. Weather is split into 3 types (clear, rain/heavy clouds, storms), both for ease of understanding and playability, and also as it is consistent with US Army doctrine of no, moderate, and severe degradation groupings of weather effects (see *FM 34-81-1 Battlefield Weather Effects*, Headquarters, Department of the Army, 1992, https://www.bits.de/NRANEU/others/amd-us-archive/FM34-81-1%2892%29.pdf).

Submarines

The sub detection effects are both a result of noise caused by the weather, and the result of the weather affecting operations (e.g. aircraft cannot conduct ASW operations in a storm as well as normal).

Ground Combat

Effect on ground operations is mix of degradation of movement, ability to detect the enemy (both due to sensor degradation and grounding of reconnaissance assets), and personnel fatigue (for piles of detail, see *FM 34-81-1 Battlefield Weather Effects*, Headquarters, Department of the Army, 1992, https://www.bits.de/NRANEU/others/amd-us-archive/FM34-81-1%2892%29.pdf)

[14] Detection and Tracking

Tracking vs. Detection

Tracking here is not just knowing where something is loosely, but knowing where it is more or less exactly in real time. Loose tracks (i.e., the general location) in the game are more or less always known, but the ability to track a system in real time to strike it is much harder (e.g., "being detected" in game terms). As such, think about the chance of detection as Chance of finding the target x Chance of being able to maintain continuous track on the target = Detection (Finding and Track). This, for ease, also includes Identification, subsumed within. This is why a target like a CSG in the Pacific is more difficult to find. While you may get a glimpse of it (e.g., see its location on the board), you will have a hard time being able to get a track on it (detection marker on it).

Approximate Locations (Or Why You Can See The Units On The Board)

Approximate areas are always known for most units, land units and air units as they are easy by satellite, UAV, and aerial reconnaissance, or from HUMINT, OSINT, cyber sources, captured personal, etc. The other main reason is the massive complexity and increase in time involved if the game were designed to be double blind (though it can be done, and some element can be included by using blocks for the units which I do for the physical version of the game).

Ships approximate position by long range over the horizon radar would be known, using ground based over the horizon radar out to 3000km with a CEP of 36-178km (22-110mi, basically the size of a hex, remembering that a CEP is a 50% chance to be in it, and the average of 22-100 is 60 or approximately ½ of a hex, so the 95% chance seems to fall roughly around a hex size for game purposes), or space based with extended coverage (the Chinese have 18 passes a day, 3,500km coverage). See *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, published 2015, Heginbotham et. al., pg. 157-159, particularly footnote 12. *Keeping Watch* (Oishee Majumdar and Mohammed Naqi Wasif, Janes Defence Weekly, 8 November 2023, pg. 24) lists Chinese OTH Radars as having a range between 500-4,000km, it also states that a max detection range versus a destroyer for the OTH radar in the Spratly Islands is 250km active, 450km passive (note that larger ships and groups of ships will be more detectable than a single destroyer however).

Assets Represented (and How to Defeat Them)

- OTH radars and SIGINT satellites would probably be used to cue other assets, such as EO/IR and SAR satellites (*The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, published 2015, Heginbotham et. al., pg. 159-163) as well as SIGINT satellites (*Shipkillers: From Satellite to Shooter at Sea*, Dwayne A. Day, Monday, June 28, 2021, https://www.thespacereview.com/article/4204/1)
- maritime patrol aircraft or drones
- ELINT
- HUMINT
- OSINT

- The now famous) ISR balloons (used by both the US and China, https://www.army.mil/article/277487/3d_mdtf_demonstrates_ability_to_operate_in_the_indo_pacific), https://www.taipeitimes.com/News/taiwan/archives/2025/02/07/2003831501 -add to source list.
- USV's (Saildrones, ect.),
- Hydrophone networks
    - Ball, Desmond, and Richard Tanter. "US SOSUS Stations." In The *Tools of Owatatsumi: Japan's Ocean Surveillance and Coastal Defence Capabilities*, 51–54. ANU Press, 2015. http://www.jstor.org/stable/j.ctt13wwvvt.15, pg. 53
    - *Invisible nuclear-armed submarines, or transparent oceans? Are ballistic missile submarines still the best deterrent for the United States?*, Bulletin of the Atomic Scientists, 2019, Vol. 75, No. 1, 30–35, https://doi.org/10.1080/00963402.2019.1555998, pg. 33-34
    - http://www.hisutton.com/Cn_Underwater_Great_Wall.html,
    - https://www.thedrive.com/the-war-zone/17903/china-reveals-it-has-two-underwater-listening-devices-within-range-of-guam
- Buoys (https://www.theglobeandmail.com/politics/article-canadian-military-found-chinese-monitoring-buoys-in-the-arctic/),
- Coast guard, maritime militia, and fisherman as ISR assets (*China Maritime Report No. 21: Civilian Shipping and Maritime Militia: The Logistics Backbone of a Taiwan Invasion*, Lonnie D. Henley, 2022, https://digital-commons.usnwc.edu/cgi/viewcontent.cgi?article=1020&context=cmsi-maritime-reports, pg. 6).

These can be defeated by strategic, operational, and tactical deception, PSYOPS, camouflage/concealment, dispersal, decoys (both physical and in the EM spectrum), looking unimportant, and degrading, destroying, and denying enemy sensors/ISR chain (*Preparing to Win the First Fight of the Next War*, Feb 23, 2024 Maj. Gen. Curt Taylor, https://mwi.westpoint.edu/preparing-to-win-the-first-fight-of-the-next-war/, *Preparing Your Unit to Win the First Fight of the Next War*, March 1st, 2024 Maj. Gen. Curt Taylor, https://mwi.westpoint.edu/preparing-your-unit-to-win-the-first-fight-of-the-next-war/, *Thinking Inside the Box – The Gauntlet, Episode 6: Command Post Survivability*, Maj. Steven Pyles and Capt. Seth Revetta, https://www.dvidshub.net/podcast/574/thinking-inside-the-box-the-gauntlet, 22:30), etc.

Submarines additionally can be detected at longer ranges (25-75nm) by specialized ocean surveillance ships like the US's T-AGOS ships (*The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, published 2015, Heginbotham et. al., pg. 191), alongside the hydrophone networks and buoys. Of course, submarines are the necessary sacrifice of accuracy here by knowing the hex that they are in, but they still only represent a loose position in a 6,495 mi^2 area.

The ability of all units to see (and strike) a unit once it has been detected, is assumed both for ease, and to simulate C4ISR networking together all units' operating picture. Of course, if this bothers you the game can be run double blind or with some sort of additional C2 rules if desired.

[15] *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017, RAND*, published 2015, Heginbotham et. al., pg. 158, 165

[16] **Naval Detection**

For a concise overview of search theory see *Fighting the Fleet: Operational Art and Modern Fleet Combat*, Jeffery R. Cares and Anthony Cowden, 2021, Naval Institute Press, pg. 34-45. Specifically for this game, *How to Make War,* 4th Edition, James F. Dunnigan, pg. 227 gives the following surface search rates per hour for a task force of 10-12 ships:

- Task force – 2,000 km^2 per hour
- Task force using helicopters – 30,000 km^2 per hour
- Task force with fixed wing aircraft to scout – 100,000 km^2 per hour

Given that SAG's, ESG's, and CSG's, in this game are ½ to 1/3rd of the size as a task force (4-5 ships), I give the non-fixed wing categories only 45% of the rate given to them by Dunnigan, and given the turn time of days, convert this into a day rate and also give it in hexes (and multiples of hexes). Note when using

helicopters with less aviation facilities than in a task force, and the need to potentially keep helicopters available for ASW, the rate of search may be even less in one of the games units.

Unit	km^2 per day	Hexes searched per day	Area 3 hexes across searched per day	Area 5 hexes across searched per day
Area Searched		16,822 km^2	151,402 km^2	420,562 km^2
Task Force	21,600 km^2	1.2 hexes/day	.14 megahexes/day	.05 maxhexes/day
Task Force Using Helicopters	324,000 km^2	19.2 hexes/day	2.14 megahexes/day	.77 maxhexes/day
Task Force with Fixed Wing Aircraft to Scout	2,400,000 km^2	142.2 hexes/day	15.9 megahexes/day	5.7 maxhexes/day

We can look at this in terms of how many sweeps per day are conducted across the area, giving us a rate in hours that it takes to look at the given area. I'll also include an area 7 and hexes across here for illustration as I need it later:

	Hours per Full Sweep of Area				
Unit	**Area 1 hex across**	**Area 3 hexes across**	**Area 5 hexes across**	**Area 7 hexes across**	**Area 9 hexes across**
Task Force	20 hours	–	–	–	–
Task Force Using Helicopters	1.25 hours	11.2 hours	31 hours	–	–
Task Force with Fixed Wing Aircraft to Scout	.17 hours	1.5 hours	4.2 hours	8.27 hours	13.6 hours

SAG's will probably operate somewhere between the Task Force and the Task Force Using Helicopters, while ESG's with some more helicopter deck space to spare will probably operate as a Task Force Using Helicopters. CSG's will obviously operate as a Task Force with Aircraft.

From this, all ships have a very good chance to detect other units in their hex (with the small chance that they miss the enemy due to both sides being on high EMCON levels being negligible (I would guess perhaps 5% or so, so a 1 on a d20, but the chance of both sides missing each other is so low and would add a d20 to what is otherwise a simple d10 system, so is left out for playability). Beyond this, ESG's have a chance at detecting an enemy in an adjacent hex (I will say a 8+, or 30% chance). CSG's always detect in adjacent hexes, with a very good chance (4+, 70%) in the next ring, and a good chance (6+, 50%) in the next ring, and some chance in the final ring (8+, or 30% chance).

[17] These units are large and have many means for being detected, and it makes the game easier to run. Via drone within 15km are able to be well tracked, and out to 40km deliberate reconnaissance is likely to be common (though note that this is dependent on satellite communications) and tactical SIGINT is passed to brigade level units. (see *Tactical Developments During the Third Year of the Russo–Ukrainian War*, Jack Watling and Nick Reynolds, February 15th, 2025, https://static.rusi.org/tactical-developments-third-year-russo-ukrainian-war-february-2205.pdf, pg. 15)

[18] Their small footprint inherently makes them stealthy as well as fact that they are designed to try to hide, but if you want a source https://breakingdefense.com/2019/04/armys-multi-domain-unit-a-game-changer-in-future-war/

[19] Naval Combat (General)

This section is *generally* informed by the following:

- *Fleet Tactics and Naval Operations 3rd Edition*
    - Note I feel most comfortable in removing the qualitative factor of seamanship in surface combat after Hughes discussion on this (pg. 18-19).
- *Carrier Killer, China's Anti-Ship Ballistic Missiles and Theater of Operations in the early 21st Century* (2022), Gerry Doyle and Blake Herzinger, specifically Chapters 3, 4, and 5
- *A Balanced Fleet,* by Dr. Nick Bradbeer
- *Naval Wargaming Beyond the Classroom*, Dr. Nick Bradbeer, Lecture, November 28, 2023

- *Proceedings of the US Naval Institute* (perhaps starting from 2021 when I began reading them in earnest)

[20] Range for all three of these is under 100 nautical miles. *If You Can't See 'em, You Can't Shoot 'em: Improving US Intelligence, Surveillance, Reconnaissance, and Targeting*, by Seth Cropsey and Bryan McGrath , November 2019 https://s3.amazonaws.com/media.hudson.org/Cropsey_Improving%20US%20Intelligence%20Surveillance%20Reconnaissance%20and%20Targeting.pdf, pg. 13.

[21] Assuming 18 x aircraft, each armed with 2 missiles (see *Armed to the Teeth*, Akhil Kadial, Janes Defense Weekly, 1 February 2023, pg. 22-27 (pg. 22) for # of munitions carried, 2 AShM or air to surface missiles), this is 36 missiles, perhaps more/less depending on the size of the strike package and supporting assets.

[22] *Armed to the Teeth*, Akhil Kadial, Janes Defense Weekly, 1 February 2023, pg. 22-27 (pg. 22)

[23]https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Selected_Acquisition_Reports/FY_2012_SARS/F-A-18E-F_December_2012_SAR.pdf (2012)

[24] https://www.airforce.gov.au/technology/f-35a-specifications (Accessed March 5, 2022)

[25] https://missilethreat.csis.org/missile/hong-niao/ (Accessed May 28, 2022)

[26] [IV range] https://missilethreat.csis.org/missile/tomahawk/ (accessed May 28, 2023), [V range] https://www.defensenews.com/naval/2020/12/14/the-us-navy-has-an-upgraded-tomahawk-heres-5-things-you-should-know/ (2020)

[27] With lower Pk's for interceptors, a shoot-shoot-look-shoot strategy, or the need to shoot 3 or more times, a ratio of 2:1 defensive to offensive missiles is roughly the minimum required to stop a given number of missiles. While neither of these (low Pk, S-S-L-S, 3+ engagements) would always be the case individually, overall, this ~2:1 rule is the best combination of being close to reality overall (at least for the purpose of modeling here) and being simple. See *Commanding The Seas - The U.S. Navy And The Future Of Surface Warfare* by Brian Clark from the Center for Strategic and Budgetary Assessment (2017) https://csbaonline.org/uploads/documents/CSBA6292-Surface_Warfare_REPRINT_WEB.pdf pg. 17-18.

[28] **Missile Combat Table**

This table is based on my own custom salvo combat model informed by:

- Missile Hits
  - *Fleet Tactics and Naval Operations 3rd Edition*
  - *Fighting the Fleet: Operational Art and Modern Fleet Combat*, Jeffery R. Cares and Anthony Cowden, 2021, Naval Institute Press
    - Note high variability in this damage table (e.g. randomness) has backing (pg. 18)
  - *Using kill-chain analysis to develop surface ship CONOPS to defend against anti-ship cruise missiles* Smith, Roy M. Naval Postgraduate School (2010)
  - *The First Battle of the Next War Wargaming a Chinese Invasion of Taiwan* (Mark F. Cancian, Matthew Cancian, and Eric Heginbotham, January 2023, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/230109_Cancian_FirstBattle_NextWar.pdf?VersionId=WdEUwJYWIySMPIr3ivhFolxC_gZQuSOQ, pg. 30-32. Note I have some major disagreements with the overuse of historical numbers in this analysis and some assumptions made, it is worth noting that the outcomes are still relatively similar to those in my table.
  - *A Balanced Fleet* – Dr. Nick Bradbeer.
- Survivability
  - Historical Analysis - To determine survivability analysis of missile and bomb effects against military grade ships built after 1970 sunk/put OOA, and ships hit by missiles even if they were not sunk, I did an analysis of missile and bomb effects against military grade ships. Ships damaged by mines were not included as they strike below the waterline. The given data may not account for advancements in damage control techniques and materials on newer ships. Full data and assumptions available upon request.
  - My views on survivability are mostly informed by *Naval Survivability and Susceptibility Reduction Study - Surface Ship*, Steven Loke Yew Kok, Naval Postgraduate School, Thesis, September 2012, https://apps.dtic.mil/sti/pdfs/ADA567704.pdf, pg. 1-94

- *A Balanced Fleet* – Dr. Nick Bradbeer.

This table roughly assumes that 2-3 hits are required to kill, or mission kill a ship, so a SAG would require 8-15 hits to kill while amphibs, carriers, etc. require more. See later footnotes for more of a discussion on this topic. Note also that this assume that all ships are roughly equivalent in terms of design for damage control and the effectiveness of damage control crews. This may not be the case with older Chinese ships whose design may be not as optimal for damage control (see Preble Hall Episode 231: Dr. Sarah Kirchberger PLA Navy Part II, https://podcasts.apple.com/gb/podcast/dr-sarah-kirchberger-pla-navy-part-ii/id1485514337?i=1000651655791, ~32:00).

[29] Naval units only start moving at half speed when they take a second damage as at the second damage the mission critical ships (carrier, amphib, etc..) have been damaged and are slowed. At lower levels of damage where only escorts are damaged, they will be left behind if necessary and will not affect the speed of the group. A CSG and ESG only experience a decrease in ASW effectiveness when the flight decks start getting damaged as it limits the number of helicopters it can have active whereas with a SAG losing a ship seriously decreases the task force's ASW capabilities.

[30] The reason for a 3rd damage on CSG's and ESG's is due to the ability of larger combatants to 1) provide more ISR and (slightly) more defensive capacity, 2) to provide extra assistance (beyond what a SAG would provide) to other ships in the task force if damaged (extra damage control teams, helicopters, ability to take ships into tow, etc.), 3) to soak up a lot of damage as they are big. Dunnigan gives Nimitz-class carriers as requiring 10 hits to be mission killed, and a Wasp-class as requiring 8 (see *How to Make War,* 4th Edition, James F. Dunnigan, pg. 240)

With the larger combatants LPD, LHD, carriers, etc. (and carriers especially) it seems unlikely that a single AShM could sink them short of a very lucky series of events, ala Japanese carriers at midway (which nowadays operations are conducted and ships designed in such a way to prevent), and that "sunk" here really represents a mission kill. For more on this, and the source that I draw my view of carrier battle damage from see *Carrier Killer: China's Anti-Ship Ballistic Missiles and Theater of Operations in the Early 21st Century* by Gerry Doyle and Blake Herzinger, pg. 21-22.

These views has been double checked with David manly

[31] It should be noted that a "sunk" result does not necessary mean that all ships are sunk, but rather that the unit (CSG, SAG, etc.) has lost so many ships, or sustained such damage that it is unable to continue operations and must return to repair yards for a long period of time, e.g. a mission kill. As major Blue repair yards not under kinetic threat from Chinese fires are far away from the battle space, even moderate damage can result in a mission kill (See *Forward Battle Damage Repair Keeps Ships in the Fight*, Proceedings, January 2022, Cmdr. Trevor Prouty USN, pg. 20). Also consider also the US may not be able to repair surface combatants in any reasonable amount of time. In addition, as US forces do not have any destroyer tenders, repair ships, and or sufficient tug capability, the number of mission kills that have to be abandoned instead of taken under tow and repaired may be higher. (see *Sustaining The Fight: Resilient Maritime Logistics For A New Era*, Timothy A. Walton, Ryan Boone, Harrison Schramm, Center For Strategic And Budgetary Assessments, 2019, pg. 62-63, 65-66). For the Chinese as their yards are within the area of operations, ships being repaired are likely to be struck again and damaged/destroyed, so the chance of a mission kill becoming a real kill is much higher for them.

[32] Submarine Combat (General Information)

The following pieces generally inform this section:

- *Use Emerging Technology for ASW* by Cpt. Walker Mills USMC, Lt. Cmdr. Collin Fox USN, Lt. Cmdr. Dylan Philips-Levine USN, and Lt. Cmdr. Trevor Philips-Levine USN. October 2021 Proceedings, pg.32-37, pg. 34-35 especially. And the response to it https://www.thedrive.com/the-war-zone/reviving-the-use-of-navy-tactical-jets-as-submarine-hunters (2023)
- *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, published 2015, Heginbotham et. al., pg. 184-197, somewhat pg. 207-214

- *Calculation of Barrier Search Probability of Detection for Arbitrary Search Tracks*, Wyatt J. Nash, Naval Postgraduate School Thesis, March 2000, https://apps.dtic.mil/sti/pdfs/ADA378067.pdf
- *Improved Anti-Submarine Warfare (ASW) Effectiveness MSSE Capstone Project*, Naval Postgraduate School, Broadmeadow et. al., 2008, https://apps.dtic.mil/sti/tr/pdf/ADA483343.pdf, pg. 39-48
- *U.S. Diesel Boats? Never Again!* by Cmdr. Cameron Aljilani in *Undersea Warfare,* Issue 64, Winter 2018, pg. 6-9
- *Airborne Anti-Submarine Warfare: From the First World War to the Present Day*, Michael E. Glynn, Frontline Books, 2022, ISSBN 978 1 39909 273 98.
- Tactical Snippets
    - *Focusing on ASW in RIMPAC 2002* by JOCS(SW) Phil Eggman in *Undersea Warfare*, Volume 5, Number 1, Fall 2002, pg. 8-10
- On Hydrophone Detection
    - *Invisible nuclear-armed submarines, or transparent oceans? Are ballistic missile submarines still the best deterrent for the United States?*, Bulletin of the Atomic Scientists, 2019, Vol. 75, No. 1, 30–35, https://doi.org/10.1080/00963402.2019.1555998
- On Ocean
    - *Taking the Measure of the Battlespace: Satellite Altimetry's Vital Role in Undersea Warfare*, Ed Gough, *Undersea Warfare*, Spring 2011, pg. 20-23.

[33] This method of having submarines exist in a quantum state is slightly artificial but forces two things. One, it forces sweeping by ASW assets against subs to "lock them down". Two, it creates uncertainty as to where subs are at any given point. The movement storage maximum is only there due to piece considerations (information state on blocks is higher but limited), balance, and as it means that subs are localizable to a (very large) area, but not a specific area.

[34] This represents the ability to operate ASW aircraft for long periods required to persecute a contact. If superiority or supremacy are not present, there is a good chance the aircraft will not fly the mission due to risk or will be driven off by enemy aircraft.

[35] Submarines moving at high speed are more likely to cavitate and just make much more noise in general, making them easier to detect.

[36] Ships moving at high speeds are unable to deploy their towed arrays (the exact speed varies highly, this is an extreme average, based on a conversation with Dr. Nick Bradbeer of the UCL Dept of Mechanical Engineering in which I pushed him for a guesstimate, thus any mistake is on me not giving him the chance to come up with a proper answer.).

[37] This provides the benefit of bottom sitting (you are very, very quiet and hard to detect), but lack of mobility means that you can only cover that area (so there is no benefit to detection).

[38] Note that this is an extremely simplified view of a highly complex system, and the numbers here are based on conversation with Dr. Nick Bradbeer RCNC and a Royal Navy Lt. Cmdr. Exact numbers are pure guesses by the author as to effect. This simplification is especially true in the context of the South China Sea, see pg. 24 of *Blue Water Buildup*, Aika Torruella, Alessandra Giovanzanti, Georgios Papangelopoulos, and Matteo Scarano, Janes Defense Weekly, 18 May 2022, pg. 22-29 – "high maritime traffic (especially in the South China Sea), marine life, industrial coastal infrastructure, currents and a complex seabed, temperature, and salinity profile, there is an inhomogeneous and noisy undersea environment. In many areas there is also a high sea bottom reverberation level. The result is an operating environment in which passive and active ship mounted sonars are challenged to meet ASW detection, classification, and target—tracking requirements". One key difference between shallow coastal waters and open ocean is the amount of maritime traffic leading to an increase in overall ambient noise to cover submarines (see *Tides of Change, China's Nuclear Ballistic Missile Submarines and Strategic Stability*, Tong Zhao, Carnegie Endowment for International Peace, 2018, pg. 27), though this is likely to change in a full scale war. Also note that shallow water is not only noisier, but limits passive sonar effects as well (*Naval Wargaming Beyond the Classroom*, Dr. Nick Bradbeer, Lecture, November 28, 2023). Open ocean has less variation in the water column than shallow water, making sonar search more efficient, and is also generally quieter (both due to less shipping a less marine life). Additionally

"long range acoustic arrival paths such as convergence zones and the Deep Sound Channel (DSC)" may be present. See *Airborne Anti-Submarine Warfare*, Michael E. Glynn, Frontline Books, 2021, pg. 8-9

[39] The sizing of the numbers here are not based on any hard data, but are attempting to account for the effects of weather. For explanations of what effects inclement weather has on ASW see *Airborne Anti-Submarine Warfare*, Michael E. Glynn, Frontline Books, 2021, pg. 139, 141-142. Note that a large part of the effect of storms is on aircrew performance and thusly on recognition differential (see pg. 97-98 for an explanation of recognition differential).

[40] **ASW Table (General Information)**

While Chinese submarines are often discounted as being of extremely poor quality in some literature and "Blue subs are never sunk", there do exist some cases of note: In 2006 a Chinese Type 39 submarine got to within 5 miles of a carrier (though it is unclear to me how much ASW was being conducted by the CSG) https://www.cbsnews.com/news/chinese-sub-came-close-to-us-ships/, and in 2015 a Chinese submarine conducted a simulated missile attack on the USS Ronald Reagan - https://freebeacon.com/national-security/chinese-submarine-practiced-missile-attack-on-uss-reagan/. This is to say nothing of the litany of examples in NATO training of submarines managing to get kills on carriers or other surface combatants. Note however that many potential variables influenced these occurrence and they may not be representative of wartime outcomes for many reasons. The overall ability to detect (the numbers given here) are based upon the following sources:

- Expert analysis from CNA
- *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, published 2015, Heginbotham et. al., pg. 186 (Figure 7.6), pg. 191 (Table 7.9), and light mind paid to pg. 194 (Table 7.10), somewhat pg. 213 (Figure 8.6) on the relative survivability of US submarines compared to a very heavy ASW screen (note the fact that these were primarily air kills as per pg. 223)
- From H.I. Sutton:
    - https://twitter.com/CovertShores/status/1554804240006238210 (2022)
    - http://www.hisutton.com/Chinese-Type-039C-Yuan-Class-Submarine.html (2021)
    - http://www.hisutton.com/Chinese-Navy-Type-093-Shang-Class-Submarine.html (2020)
- The availably and usefulness of various airframes for conducting ASW: https://www.thedrive.com/the-war-zone/reviving-the-use-of-navy-tactical-jets-as-submarine-hunters (2023), see especially the latter end of the section "So easy, a Harrier pilot can do it", and partly the problems presented in *Use Emerging Technology for ASW* by Cpt. Walker Mills USMC, Lt. Cmdr. Collin Fox USN, Lt. Cmdr. Dylan Philips-Levine USN, and Lt. Cmdr. Trevor Philips-Levine USN. October 2021 Proceedings.
- *Quick Look Report "Chinese Undersea Warfare: Development, Capabilities, Trends"*, April 2023, China Maritime Studies Institute https://www.andrewerickson.com/2023/05/quick-look-summary-cmsis-11-13-april-2023-conference-chinese-undersea-warfare-development-capabilities-trends/ (2023) for a look at Chinese submarine capabilities.
- *Blue Water Buildup*, Aika Torruella, Alessandra Giovanzanti, Georgios Papangelopoulos, and Matteo Scarano, Janes Defense Weekly, 18 May 2022, pg. 22-29 for a look at Chinese ASW capabilities and the ASW environment of the Pacific. See figure pg. 23: of their escorts 88 (62%) are fully equipped for ASW, 8 (6%) are partly equipped, and 46 (32%) are not equipped (hulls only, ASW helicopters could be embarked). Notes on ASW helicopters on pg. 27.
    - The overall lack of Chinese ASW assets (both fixed wing and rotary wing) at this time is also of interest here, though this problem will be remedied over time.
- To some degree *Tides of Change, China's Nuclear Ballistic Missile Submarines and Strategic Stability*, Tong Zhao, Carnegie Endowment for International Peace, 2018, particularly pg. 26-27, 36, though this report is about Chinese SSBN's. Notably I rate Type-94's as equivalent to Type 93's as "a

Chinese 093-class SSN — which is believed to be considerably quieter than the 091-class SSN, and which may have a noise level similar to that of the 094-class SSBN" (pg. 36).

- Preble Hall Episode 231: Dr. Sarah Kirchberger PLA Navy Part II, https://podcasts.apple.com/gb/podcast/dr-sarah-kirchberger-pla-navy-part-ii/id1485514337?i=1000651655791, 18:55.
- *Improved Anti-Submarine Warfare (ASW) Effectiveness MSSE Capstone Project*, Naval Postgraduate School, Broadmeadow et. al., 2008, https://apps.dtic.mil/sti/tr/pdf/ADA483343.pdf, especially pg. 39-48, 97-152 (pg. 129 especially), 180-183 (note I consider the various key assumptions and limitations to nullify each other when I use the data from this work, in part as it makes things easy (and I have no other data source to go to for some of these other factors to create a model) and in part as it wraps up a number of theater attrition factors that are not otherwise accounted for). Various bits of note follow, mostly so I don't have to go digging for them again when it becomes important:
    - On Kilo SSK's: "Its advanced MGK-400EM Sonar is capable of detecting surface ships at ranges greater than 40 miles and submarines at ranges beyond 10 miles" (pg. 44) – ask Ethan to do some compute here. Given a hex of a given size (100 mi), and two searchers moving a 10.8 knots (the max stealthy movement rate of subs in game, 2 hexes would be 7.21 knots), each detecting to 12 miles (in a radius), what's the chance in 24 hours that one or the other would detect the other?
    - "In the modeling of other alternatives, the submarine speed is taken to be 5 knots. In this case its speed is taken as 10 knots, under the assumption that it will be less concerned with stealth when outside the CSG OA. It can be reasonably assumed that the transiting submarine prior to entering the CSG OA will change its behavior to a stealthier, continually submerged mode." (pg. 118-119)
    - The probability of detection by a P-3 MPA defending a CSG over an 8 hour period, attempting to detect a SSK (surfacing 1 of every 6 hours) moving to attack a CSG is ~5%. (pg. 122).
    - Recognition a threshold for a sonobuoy is 20dB (pg. 126), background noise is on average 70dB, with detection values being 20dB for active and 10dB for passive sensors (pg. 108), a Kilo SSK gives off 10dB (pg. 106)
- *Airborne Anti-Submarine Warfare: From the First World War to the Present Day*, Michael E. Glynn, Frontline Books, 2022, ISSBN 978 1 39909 273 98, pg. 27-43

[41] Data from baseline scenario in *Improved Anti-Submarine Warfare (ASW) Effectiveness MSSE Capstone Project*, Naval Postgraduate School, Broadmeadow et. al., 2008, https://apps.dtic.mil/sti/tr/pdf/ADA483343.pdf, pg. 129. Pk is .665 (65% chance) so 8+ on a d20.

[42] Data from *Improved Anti-Submarine Warfare (ASW) Effectiveness MSSE Capstone Project*, Naval Postgraduate School, Broadmeadow et. al., 2008, https://apps.dtic.mil/sti/tr/pdf/ADA483343.pdf, especially pg. 122. The probability of detection by a P-3 MPA defending a CSG over an 8 hour period, attempting to detect a SSK (surfacing 1 of every 6 hours) moving to attack a CSG is ~5%. (pg. 122). Given that AIP submarines are becoming more common (so less/no surfacing) and only China's diesels are really noisy, I estimate a 5% chance for every sub, except Chinese Diesels (which are noisy, and a great number of which are not AIP). Japanese Diesels of which ~½ are currently not AIP are rated to be better because they are not as noisy.

[43] A sonobuoy array has a 57% chance of detecting a submarine (Data from Figure 66, *Improved Anti-Submarine Warfare (ASW) Effectiveness MSSE Capstone Project*, Naval Postgraduate School, Broadmeadow et. al., 2008, https://apps.dtic.mil/sti/tr/pdf/ADA483343.pdf, pg. 129). A hydrophone network, more deliberately laid and not having to worry about drift of its sensors is probably better. Thus, I rate it as having a 70% chance of detecting the enemy (7+ on a d20). The author is aware that due to differences in the effectiveness of sensors the barrier may be constructed differently, but assumes (as no better data is present) that if sensors are better/worse they will be placed further/closer to achieve the same effect as presented.

[44] **ASW Attack**

Estimating the Pk of a torpedo is difficult (see the section on "Kill Probability" in https://www.strikepod.com/strikepod-command-counter-poseidon-2/ for a brief overview). The Pk of a ASROC is ~.2 (see pg. 39-40 of *Probability of kill for VLA ASROC torpedo launch*, Valerio, Stephen M. Monterey, California. Naval Postgraduate School, 2009, https://calhoun.nps.edu/bitstream/handle/10945/4820/09Mar_Valerio.pdf). The paper takes as a given that the target has been detected (as per the detection table) and assumes that 3 shots from a torpedo with a Pk of .2 occurs against the sub (.512 chance of 3 misses, or .488 cumulative chance of a hit on the Sub), this choice of 3 attacks was vibe checked by dr nick bradbeer. I choose three shots in a given engagement as it makes good probabilities (it's ~50%) and seems a reasonable number to the author for the maximum number of torpedoes fired across a whole sub vs. sub or sub vs. ASW engagement which may go through several phases of attempting to detect and attack the sub over several hours in a 24-hour period which makes up one turn. Thus the 3 torpedoes may well be spread out over several minutes or several hours, but the aggregate over one turn is roughly 3. E.g., approximately three is a reasonable number of possible engagements and at three the chance of a kill or mission kill is high enough to warrant rolling dice. In this context the Pk is almost the same as the Ph because hitting a submarine is either a) enough to kill it, or b) enough to make it loud enough to kill it with a follow-on attack shortly after. If the sub is attacked, but not killed it suffers a temporary mission kill for the rest of the turn in that it needs to evade and reposition to carry on its mission. (See *Commanding The Seas - The U.S. Navy And The Future Of Surface Warfare* by Brian Clark from the Center for Strategic and Budgetary Assessment (2017) https://csbaonline.org/uploads/documents/CSBA6292-Surface_Warfare_REPRINT_WEB.pdf pg. 25)

Note that as this is a 50/50 chance of kill, it would be easy to say "you sink the sub on an even number, you don't on an odd number", but for a number of hard to detect subs that significantly biases the chances of sinking them when detected and is less thrilling that rolling to see if you escape (or sink a sub) once it has been detected. If you are crunched for time, just use the 50/50 method.

It could be argued that the lower sprint speed of diesel boats, and more limited time that they can sustain that sprint speed (*U.S. Diesel Boats? Never Again!* by Cmdr. Cameron Aljilani in *Undersea Warfare,* Issue 64, Winter 2018, pg. 6) should increase the likelihood of them not escaping (perhaps a -1 or -2 on escaping), but I do not do this in favor of playability.

[45] Basically, with a sub sweeping in front of a group, the speed prevents a sub from moving around into the baffles of the moving group and attacking, so head on attacks must be made forcing the attacker to kill the sub or attempt to slip by the sub with attempting to slip by being a very bad idea. (Discussion with RN Lt. Cmdr., May 17th, 2024). See also *Improved Anti-Submarine Warfare (ASW) Effectiveness MSSE Capstone Project*, Naval Postgraduate School, Broadmeadow et. al., 2008, https://apps.dtic.mil/sti/tr/pdf/ADA483343.pdf, pg. 45-46

[46] *U.S. Diesel Boats? Never Again!* by Cmdr. Cameron Aljilani in *Undersea Warfare,* Issue 64, Winter 2018, pg. 9

[47] **Submarine Attacks Special Rules**

For sub attacks with missiles this represents the fact that submarines engage from within the detection and engagement envelope of the defensive systems of the group, thus allowing for less chances to engage incoming missiles making their more limited salvo more effective. This also rolls in torpedo attacks as well into the same system without having to make something separate.

Submarines can score max 1 damage (sinking 1 or two ships) as they come under extreme risk by sticking around, and would tend not to try to attack multiple targets. See *Airborne Anti-Submarine Warfare*, Michael E. Glynn, Frontline Books, 2021, pg. 12

[48] In Mobility Guardian 2023, units were able to deploy their maintainers and other supporting elements in 38-42 hours, with RAF forces able to get to the pacific in 21 hours (*Inside the Air Force's massive mobility war game in the Pacific*, Rachel S. Cohen, Aug 9, 2023, https://www.airforcetimes.com/news/your-air-force/2023/08/09/inside-the-air-forces-massive-mobility-war-game-in-the-pacific/). If necessary limited operations can be conducted by a squadron's teeth element operating in a very expeditionary capacity, backed by one or two cargo planes/tankers as demonstrated by US exercises in the Pacific, then allowing the

rest of the squadron to flow in over several days (so operations can be conducted from the first day in a limited capacity). Alternatively, if there are already forces there, they are merely reinforcing existing squadrons and can leach off of their logistics/maintainers for a short period until the squadron's own logistics and maintenance arrive. Assuming friction will make it worse than the real world to deploy than in the exercise, but that this more expeditionary limited operations can be employed. 2 days, (48 hours) seems a good number to go with. Additionally, having it only be two days makes it easier for Control.

[49] See *Resilient Aerial Refueling: Safeguarding the US Military's Global Reach,* Timothy A. Walton & Bryan Clark, Center for Defense Concepts And Technology, Hudson Institute, 2021, https://s3.amazonaws.com/media.hudson.org/Walton%20Clark_Resilient%20Aerial%20Refueling.pdf , pg. 34

[50] The US trains for rapid deployment and support of operations at a distance and on short notice. Other militaries do not do this to the same extent, and consequently, take longer to redeploy units.

[51] This is planned and trained for, but I cannot find a source on how long it takes precisely. Aircraft would be easier to move than support assets like ground crews, fuel, and munitions, but Taiwan is also not a large place and this is (supposedly at least) trained for.

[52] Air Combat (General Information)

This section is generally informed by the following:

- *Air Force Doctrine Publication 3-01 Counterair Operations,* https://www.doctrine.af.mil/Portals/61/documents/AFDP_3-01/3-01-AFDP-COUNTERAIR.pdf, especially pg. 2-7.
- *The Russian Air War and Ukrainian Requirements for Air Defense,* Justin Bronk with Nick Reynolds and Jack Watling, RUSI, November 2022, https://static.rusi.org/SR-Russian-Air-War-Ukraine-web-final.pdf. This work identifies three key elements: effectiveness of GBAD (mainly deconfliction and electronic warfare), the value of better technology (generally radar ability, missile range and missile seekers), and consequently to the value of better technology the effects of being forced to operate at low levels. These are represented thusly:
    - Effectiveness of GBAD: due to the high overmatch in numbers between the ROCAF and the PLAAF, I assume that Chinese GBAD would rarely fire as Chinese aircraft would be the primary tool to engage threats for the Chinese IADS as Taiwanese aircraft would rarely be in range to be engaged by Chinese GBAD. Taiwan operates only medium and short ranged GBAD systems, which would be a high priority target for the PLA. As I assume a general competence for all sides in a fight, I contend that there would be heavy suppression of such systems, but that numerous SHORAD and MANPADS would have effects due to volume (as has been seen in the first year of the War in Ukraine). As a consequence of assuming general competence, this means that deconfliction is assumed to be relatively effective, and where it is not, an equal rate of fratricides occurs, meaning that I can wrap up fratricides from deconfliction as part of the general attrition of squadrons. The ground-based EW talked about in the article will be less effective than in Ukraine due to the fact that there is a great deal of water that prevents the PLA from positioning ground-based EW platforms closer to Taiwanese air defenses. Air based EW from jamming pods is already assumed to be flying with strikes and therefore does not need to be addressed specifically as part of this. Also note that the discussion of the opening days of the war from pg. 6-17 (good summary on pg. 20) indicates that IADS values should possibly be lowered at the start of the game, and then raised back to normal later (e.g. IADS isn't static), but this is not done for simplicity and as deciding values is dependent on so many known unknowns and could end up with so many different results as to be worth a PhD dissertation.
    - Better technology: this is part of the attack and defense modifiers system for various generations of aircraft. 4.5th Gen aircraft are abstracted purely for easing the work of the air liaison umpire (if the players wish to include them (+1 attack, +0 defense would be my recommendation). It is assumed that Chinese and Western missiles and radar are of comparable quality for each generation given a lack of unclassified data on the subject and my general assumption for the purposes of this game (though this should not be construed as an endorsement of this position) is that all sides are generally competent, with this extending to

their R&D sectors and military-industrial base unless otherwise known. Given the fact that most sides have some 4th Gen and 4.5th Gen aircraft in the fray, mixing the effects of 4th and 4.5th Gen aircraft, and the higher level modeling employed by this game means that the affects can be abstracted and that no side has such a distinct advantage in 4.5th Gen fighters as to be worth modeling (note that this may be incorrect for someone like the US however). Some may disagree with this point, see *Air Defense Options for Taiwan, An Assessment of Relative Costs and Operational Benefits*, Lostumbo et. al., RAND, 2016, pg. 38, the table on pg. 44, or pg. 44-45 for example.

    - Low level operations:
        - This is also discussed in other sources
            - https://www.thedrive.com/the-war-zone/a-mig-29-pilots-inside-account-of-the-changing-air-war-over-ukraine
        - This is not accounted for in this game to avoid too much complexity, but if you want to add it a -1 to attack and a +1 to defense would one way to implement it.
        - PLAAF may have to do low level operations if they fail to suppress Taiwanese air defense as Ukrainian medium range air defense forced the Russians to abandon medium and high-altitude operations (RUSI, pg. 14). If this is the case in a Taiwan scenario, then any such effects of low-level operations would be a wash. However, later sources (see other sources above, and note that while the RUSI article and the Drive article were published a month apart, the RUSI article interviews are somewhat older than the publication date), indicate that Russia may be able to operate at higher altitudes and keep the Ukrainians low.
            - Note that in light of the analysis of *Air Defense Options for Taiwan, An Assessment of Relative Costs and Operational Benefits*, Lostumbo et. al., RAND, 2016, https://www.rand.org/pubs/research_reports/RR1051.html, I feel that the Taiwanese would not be able to project an air defense bubble over the island or their forces for a long period of time given competent Chinese SEAD/DEAD operations.

- *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017, RAND*, published 2015, Heginbotham et. al., particularly pg. 49-93
- *Air Defense Options for Taiwan, An Assessment of Relative Costs and Operational Benefits*, Lostumbo et. al., RAND, 2016, particularly pg. 36-49, 53-54, 58, 60-62, 65-68, 97-121, https://www.rand.org/pubs/research_reports/RR1051.html. Note that a good chunk of this report is looking at different structures for air defense for Taiwan and as such various models may have different assumptions from current Taiwanese air defense.
- *Geopolitics Decanted, Episode 41: How Ukraine Can Survive the Exhaustion of Its Air Defense Stocks*, Dmitri Alperovitch, Justin Bronk, and Dara Massicot. April 17, 2023.
- *Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military*, Justin Bronk, Febuary 2016, https://static.rusi.org/20160201_whp_maximum_value_from_the_f-35_web.pdf
    - In general the whole report, but I find the following quote (pg. 8) particularly encapsulating: "The US Red Flag exercises have consistently proven that the key determining factors in air-to air combat are situational awareness, persistence in terms of fuel and missile stores, and pilot experience. Aircraft kinematic performance is a secondary aspect that only becomes critically important in a post-merge situation – a dogfight – where opposing aircraft are in visual contact with each other and are aggressively manoeuvring to bring the other into their sights."
- *F-15E: Flying The F-15E Strike Eagle in Air-To-Air Combat, From Dogfighting To Drone Hunting*, Thomas Newdick, Jul 1, 2024, https://www.twz.com/air/f-15e-strike-eagle-in-air-to-air-combat-from-dogfighting-to-drone-hunting
- *Ukrainian Su-27 Flanker Pilot's Rare Account Of The Changing Air War*, Thomas Newdick, Jan 3, 2025, https://www.twz.com/air/ukrainian-su-27-flanker-pilots-rare-account-of-the-changing-air-war

- On carrier airwings: https://www.defensenews.com/naval/2022/02/14/three-takeaways-from-the-us-navys-first-f-35c-deployment/
- *An Air Force for an Era of Great Power Competition*, Mark Gunzinger, Carl Rehberg, Jacob Cohn, Timothy A. Walton, Lukas Autenried, CSBA, 2019, https://csbaonline.org/uploads/documents/CSBA_AFAIS_Report_v9.pdf

[53] **What is a Squadron (and a Discussion of Sortie Rates)?**

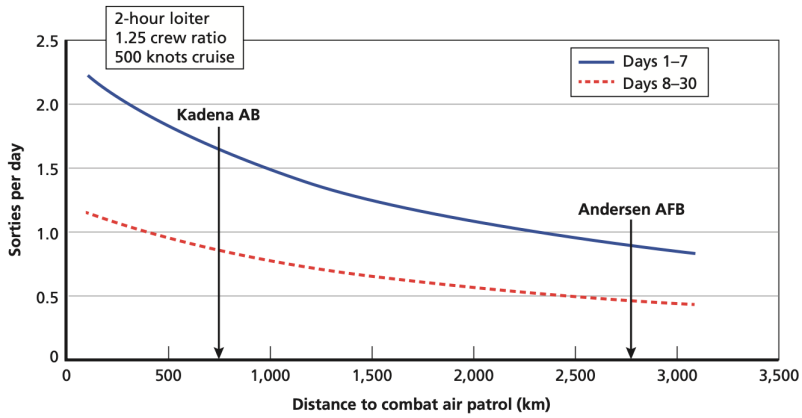
What is a Squadron?

While a "Squadron" is the unit used here (16 x 3rd or 4th Gen aircraft, or 12 x 5th Gen aircraft), given the turn length (1 day) the employment of a squadron in a sector doesn't necessary mean that all planes are up at once. A squadron indicates the capability of a squadron to conduct missions (note here that enablers are abstracted but assumed to be present), and not all the aircraft are up in the air at any given time. This could mean no sorties or several sorties per day for each aircraft depending on the mission and tasking.

Sortie Rates in the Pacific Theater

A RAND report found that "assuming a 1.25 crew ratio with weekly and monthly restrictions in place for a mission with a two-hour on-station time. Flying from Kadena AB on Okinawa (roughly 770 km from the center line between Taiwan and the mainland), U.S. aircraft could fly 1.6 sorties per day for the first seven days and 0.9 sorties per day thereafter. From Andersen AFB on Guam (roughly 2,870 km from the center line), aircraft could achieve rates of 0.8 sorties per day for the first seven days and 0.5 thereafter." Given the model they present and the numbers they give for Chinese airbases, Chinese aircraft could fly between 2-2.5 sorties per day. See *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, Heginbotham et. al., pg. 79-80. Note that Western militaries likely would have an advantage in sortie generate due to higher quality of the force, but this would be offset by the fact that they are further from the areas of battle in many cases.

Figure 4.3
Sortie Rate as a Function of Distance



SOURCE: Air Force Instruction 11-202, Vol. 3, 2010.
RAND *RR392-4.3*

The reason for the shape of the lines on this graph is 1) increased time to transit to and from the target, and 2) increased maintenance time due to an increase in flight hours as a result of the longer transit. See *Airbase Vulnerability to Conventional Cruise-Missile and Ballistic-Missile Attacks: Technology, Scenarios, and U.S. Air Force Responses*, John Stillion David T. Orletsky, RAND, 1999, https://www.rand.org/pubs/monograph_reports/MR1028.html, pg. 51, 81-84

Theoretical Sortie Rates

As a general rule of thumb for specific adjudication of things if specific numbers are needed at a specific point in time (any given hour for example): assume "1/3 of available airframes are in the fight; 1/3 preparing to launch or enroute; and 1/3 recovering, refueling and rearming" (https://www.airandspaceforces.com/article/crisis-in-the-fighter-force-eric/, Lt. Gen. David A. Deptula USAF (Ret.) and Heather Penney, Jan 2022). For a deep discussion on sortie rates (a good assumption is ~2 per day in most cases), see *Airbase Vulnerability to Conventional Cruise-Missile and Ballistic-Missile Attacks: Technology, Scenarios, and U.S. Air Force Responses*, John Stillion David T. Orletsky, RAND, 1999, https://www.rand.org/pubs/monograph_reports/MR1028.html, pg. 81-84

Higher Sortie Rates

Higher numbers of sorties (3-4 a day) in extreme circumstances for periods of time are possible, and would likely be flown, if possible, by outnumbered Taiwanese pilots to have some sort of presence in the air in the face of overwhelming Chinese numbers. This was seen in Ukraine at the start of the war: "Kryvonozhko said some pilots flew three to four sorties a day to engage Russian forces. They often skipped preflight checks and took off from shortened runways that had been bombed and then repaired overnight." (*Battle for Kyiv: Ukrainian valor, Russian blunders combined to save the capital*, Paul Sonne, Isabelle Khurshudyan, Serhiy Morgunov, and Kostiantyn Khudov, Aug. 24, 2023, https://www.washingtonpost.com/national-security/interactive/2022/kyiv-battle-ukraine-survival/), or pilots flying 2-3 sorites a night – (*Ukrainian Su-27 Flanker Pilot's Rare Account Of The Changing Air War*, Thomas Newdick, Jan 3, 2025, https://www.twz.com/air/ukrainian-su-27-flanker-pilots-rare-account-of-the-changing-air-war). In a system with poor maintenance provisions high initial sortie rates can collapse quickly however (see *Weapons and Tactics of the Soviet Army*, David Isby, pg. 22, expected Soviet sortie rate was 4-5 in a surge, 2-3 a day in the first 3 days of operation, then decreasing to 1-2 sorties a day) though if this applies to the PLARF or a ROCAF degraded by fighting is unclear (for a discussion of PLA (and some specifically on PLAAF maintenance) see *Kicking the Tires? The People's Liberation Army's Approach to Maintenance Management*, 2023, https://www.rand.org/content/dam/rand/pubs/research_reports/RRA1900/RRA1995-1/RAND_RRA1995-1.pdf).

[54] Damage here represents a combination of loss of airframes, decrease in sortie generation due to pilot and airframe fatigue, and other miscellaneous factors that decrease the overall effectiveness of the squadron. Thus, a Destroyed result does not mean that all aircraft have been destroyed, but that the squadron's effective fighting power has been reduced to the point where it has a negligible impact on the ongoing fighting. Note a relative inherent brittleness to squadrons, as they likely only have 1-2 spare aircraft to begin with (*Changes to the Air Force's Policy for Calculating Wartime Spares Requirements*, Virginia A. Mattern, 1993, https://apps.dtic.mil/sti/tr/pdf/ADA270722.pdf, pg. 3-3). Though of course, the higher the sortie rate the more a single aircraft can cover for another unavailable aircraft.

[55] While this does not act as validation of this model, note that a very similar system was arrived at by CSIS in *The First Battle of the Next War Wargaming a Chinese Invasion of Taiwan* Mark F. Cancian, Matthew Cancian, and Eric Heginbotham, January 2023, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/230109_Cancian_FirstBattle_NextWar.pdf?VersionId=WdEUwJYWIySMPIr3ivhFolxC_gZQuSOQ).

[56] Sectors are used in this system mostly for simplicity, and boundaries are based on my decisions, but match somewhat with long range SAM ranges. I am therefore making the assumption (though do not necessary agree with it) that in a full scale war, for Blue there would be adequate (abstracted in this game) tanking capability, plus the opening of Japanese air bases, and use of civilian airports/dispersed basing to provide reasonable ability to use aircraft without significant non-combat degradation (the Chinese have 40+ military airfields in range of Taiwan, plus a large number of civilian airports so this is not an issue for them). For more details on shutting down airbases via missile attacks see *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, published 2015, Heginbotham et. al., pg. 58-68, pg. 61, 71-87 specifically, pg.133-150, 40 airports = pg. 72, for a full map pg. 138.

[57] This approximately represents the "fighter sweeps" element of offensive counter air, but may also wrap up some degree of attack operations see *Air Force Doctrine Publication 3-01 Counterair Operations,* https://www.doctrine.af.mil/Portals/61/documents/AFDP_3-01/3-01-AFDP-COUNTERAIR.pdf, pg. 4-5.

[58] This represents the active air defense element of defensive counter air, see *Air Force Doctrine Publication 3-01 Counterair Operations,* https://www.doctrine.af.mil/Portals/61/documents/AFDP_3-01/3-01-AFDP-COUNTERAIR.pdf, pg. 6.

[59] This represents the fact that due to flying CAP in the area of the carrier this CAP is able to react much more than another CAP flying far away from their base.

[60] The number of squadrons here is a guess, but it is representing not having too many friendlies in the way such that it might cause problems in attacking the enemy.

[61] This represents the "Fighter Escort" element of offensive counter air. see *Air Force Doctrine Publication 3-01 Counterair Operations,* https://www.doctrine.af.mil/Portals/61/documents/AFDP_3-01/3-01-AFDP-COUNTERAIR.pdf, pg. 5.

[62] While Conducting and Escorting strikes are abstracted to squadron level in these rules, conducting a strike would likely involve some escort aircraft either from the same squadron or another, (for example a F-18 strike with Harpoons escorted by a small number of F-35's) but due to level of abstraction, they are not represented here in that manner, but rather at the squadron level.

[63] Air Support here broadly represents what the USAF calls "Counterland Operations". The distinction between Ground Support and Interdiction functionally represents Close Air Support (both pre-planned and immediate) and Air Interdiction missions, though Ground Support is broader than just CAS missions (for example attrition of enemy forces away from FLOT is an Air Interdiction effect). See *Air Force Doctrine Publication 3-03 Counterland Operations,*

https://www.doctrine.af.mil/Portals/61/documents/AFDP_3-03/3-03-AFDP-COUNTERLAND.pdf. Note that this assumes the ability of the PLAAF, PLAN, and PLAGF to conduct such missions as effectively as the US or other partners, which may be incorrect (though equal force quality is always assumed throughout these rules). See *The Improvement of the PLA's Close Air Support Capability,* Derek Solen, 2020, https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/CASI%20Articles/2020-12-17%20PLA's%20improving%20Close%20Air%20Support%20capability.pdf?ver=5Jah3h28qsohyD4SkMYz-g%3d%3d, pg. 7.

[64] It is extremely difficult to tell how effective aircraft will be in inflicting damage in this war as its effectiveness is contingent on a great bevy of factors that vary greatly at various different points (and note that "ground support" here does not just mean attacking front troops but also the rear area when applicable). This 1d2 attrition can therefore be argued over greatly (and should be changed depending on other circumstances, as always, these rules are not exhaustive). Given the potential effectiveness posed in *Air Defense Options for Taiwan, An Assessment of Relative Costs and Operational Benefits*, Lostumbo et. al., RAND, 2016, particularly pg. 61, the 1d2 attrition falls close to the numbers from the RAND report. For reference during the battle of Avdiivka (e.g. a contested air environment perhaps closer to a US-China war) Russia used 600 bombs over 4 weeks (~21.4 bombs per day), though I can find no numerical assessment of the impacts of these upon the defenders (see https://twitter.com/RALee85/status/1754672295296045359 for bomb numbers, or https://www.theguardian.com/world/2024/mar/01/ukraine-war-russia-west-hesitancy-europe which says 1,200 over 2 months), Michael Kofamn has stated that glide bombs were one of the reasons that Ukraine forces were pressed out of Avdiivka (https://twitter.com/KofmanMichael/status/1770140974443811305). In at least one part of fighting 20 glide bombs were drop on the same village during fighting (https://twitter.com/francisjfarrell/status/1789579240406401122)

More on glide bombs - https://x.com/MaxRTucker/status/1793244045818339716

Ukrainian Pravda stating glide bombs are one of the reasons for the success of the advance on Pakrovsk https://www.pravda.com.ua/eng/articles/2024/09/17/7475408/

[65] This is a combination of standoff and non-standoff SEAD/DEAD missions both by kinetic and non-kinetic means. This also include the use of anti-radiation loitering munitions (Taiwanese NCSIST Chien Hsiang, Chinese ASN-301), and abstracts in the targeting of specefic air defense assets with long range precession fires to open widows as seen in Ukraine (though note that special forces attacks on air defense is covered in special forces missions and not abstracted in here). This overall represents the localized suppression, and perhaps some non-localized suppression. Area of Responsibility (AOR) or Joint Operations Area (JOA) suppression is not explicitly modeled in this game both for ease and due to the high regeneration of most air defense assets for both sides (China via its number and landmass allowing it to reposition assets quickly, Blue though the number of U.S. Patriots and other systems available). AOR or JOA suppression is somewhat accounted for in the ability of missile salvos to degrade IADS. See *Air Force Doctrine Publication 3-01 Counterair Operations,* https://www.doctrine.af.mil/Portals/61/documents/AFDP_3-01/3-01-AFDP-COUNTERAIR.pdf, pg. 5. For notes on current and future SEAD/DEAD, my thoughts are mostly shaped by commentary on the F-35's ability to support such operations from a variety of sources and more technical information from *Non-kinetic SEAD Equipment Programmes*, Richard Scott, Janes Defense and Intelligence Review, May 2023, pg. 46-50, and *HARM's Way, Kinetic SEAD Evolution*, Richard Scott, Janes Defense and Intelligence Review, November 2023, pg. 26-31

[66] **IADS**

Here IADS represents both short, medium, and long-range air defense, as well as the degradation of forces due to IADS (e.g. increasingly attacking from standoff, difference in operations, ect.). See *An Air Force for*

an Era of Great Power Competition, Mark Gunzinger, Carl Rehberg, Jacob Cohn, Timothy A. Walton, Lukas Autenried, CSBA, 2019, https://csbaonline.org/uploads/documents/CSBA_AFAIS_Report_v9.pdf, pg. 42-44

For details informing this section overall, the value of stealth, and IADS values on the map see *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, Heginbotham et. al., pg. 97-132.

On the evolving nature of IADS in the context of the Russia-Ukraine war (and the effect of persistant ISR on SHORAD), see *Tactical Developments During the Third Year of the Russo–Ukrainian War*, Jack Watling and Nick Reynolds, February 15th, 2025, https://static.rusi.org/tactical-developments-third-year-russo-ukrainian-war-february-2205.pdf, pg. 18

[67] This means in most cases a 50% decrease in effectiveness against 5th Gen aircraft in most IADS areas, and a 100% decrease in effectiveness against the B-2. The B-2 is better here than a 5th Gen aircraft as it is both stealth and high flying which degrades the performance of radar and SAMs against it.

[68] Increasing by one, rather than doubling, or some other operation is based on my view that SHORAD is a relative static value in all cases (e.g. it is always present, but is not more effective in one case or another or depending on where you are as SHORAD occurs around where the target is, not as you are flying in, in the specific case of Taiwan, (if this were Ukraine for example, the SHORAD would increase the deeper you penetrate though enemy lines). As it is well integrated as part of an IADS with cueing (e.g., SPAAGs and MANPADs) it is a static value rather than something else.

Note that this fails to account for the ability of SHORAD to be outstripped by the maneuvering force it is supposed to support if not properly coordinated or if SHORAD is not available in enough numbers, as may well happen with Taiwan's limited SHORAD inventory (For some overview of what happens when SHORAD is outstripped by the maneuvering forces see the opening of the 2023 Ukrainian summer counteroffensive, as detailed in *Ukraine's Armor Appears to Have a Russian Attack Helicopter Problem*, Thomas Newdick and Tyler Rogoway, June 15, 2023, https://www.thedrive.com/the-war-zone/ukraines-armor-appears-to-have-a-russian-attack-helicopter-problem).

[69] **The Air Combat Table: Understanding the Lethality**

The rate of damage to squadrons here is heavily colored by *Defending Mother Russia's Skies,* RUSI (July 13th, 2022), particularly the point that in the 142 days after the invasion, Ukraine had lost 19% of its pre-war stockpiles (not including decreases in readiness rates due to mechanical fatigue which are not able to be documented), in a war seeing limited amounts of air power, which also generally stayed behind the respective side's forward line own troops (FLOT). Furthermore, air operations also took place over a piece of land, where pilots are easy to recover (especially as they were likely to be shot down close to, or behind their own FLOT), something made more difficult in the contested airspace and water (instead of land) that would characterize a war in the Pacific (not to mention a lack of long-range CSAR capabilities for the US, which for the US is limited to ~250nm (https://www.twz.com/hh-60w-at-center-of-drive-to-update-air-forces-search-and-rescue-playbook) without having to rely on boat or submarine pickup, of which there are few to be spared).

The accuracy of the lethality of the air-to-air table is up for debate but given analysis in *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, published 2015, Heginbotham et. al., pg. 81, I feel that the given lethality of these rules is squarely within the bounds of probability. E.g., if a squadron of 16 aircraft can achieve a maximum of 32 kills as per the report, in an air-to-air engagement on this table, a 4th Gen fighter squadron (vs. 4th) will achieve on average 2.4 kills, and a maximum of 8 *if* it gets into an engagement (which may not happen). This is of course, assuming that the squadron is not damaged, in which case, it will perform more poorly.

Average Squadron Kills and Losses by Aircraft Generation		
	Average Kills	Average Losses
5th Gen vs. 5th Gen	.8	.8
5th Gen vs. 4th Gen	4	.8
4th Gen vs. 4th Gen	2.4	2.4

Also note that to some degree maintenance degradation and other mishaps taking out aircraft is also rolled up into this loss rate.

Note that these attrition rates per squadron work out to the following, assuming that each squadron musters 16 aircraft sorties in a day and they all get into an air-to-air fight:

Squadron Attrition Rate by Aircraft Generation		
	Average Kills	Average Losses
5th Gen vs. 5th Gen	5%	5%
5th Gen vs. 4th Gen	25%	5%
4th Gen vs. 4th Gen	15%	15%

However, this is not entirely correct as not all squadrons are always fighting for air control. Assume that 50% are either grounded, launch but don't find the enemy (or are escorting and do get into a fight), or are flying a strike or SEAD mission. From this we get the following:

Squadron Attrition Rate by Aircraft Generation Assuming a Variety of Missions		
	Average Kills	Average Losses
5th Gen vs. 5th Gen	2.5%	2.5%
5th Gen vs. 4th Gen	12.5%	2.5%
4th Gen vs. 4th Gen	7.5%	7.5%

Based on player/control decisions from one run of the game, 50% may be an overshoot (though I didn't collect good enough data at the time to get a good answer to this, and Control recollection is slightly hazy).

Let us revisit my earlier comment "to some degree maintenance degradation and other mishaps are rolled up into this loss rate." What is the per sortie loss rate of aircraft to mishaps? For a competent military under the best possible conditions like in Gulf War 2, there were 15 non-combat losses (https://web.archive.org/web/20080317110507/http://www.cnn.com/SPECIALS/2001/gulf.war/facts/gulfwar/) out of 41,404 sorties flown (https://www.airandspaceforces.com/PDF/MagazineArchive/Magazine%20Documents/2003/July%202003/0703Numbers.pdf), for a rate of .036% airframes lost per sortie.

It is of course very difficult to estimate maintenance degradation, and the one source I found with direct numbers had those numbers redacted. A proxy can be found in not mission capable-supply rates, which are (first order approximation) 25% after 30 days of fighting. (*Changes to the Air Force's Policy for Calculating Wartime Spares Requirements*, Virginia A. Mattern, 1993, https://apps.dtic.mil/sti/tr/pdf/ADA270722.pdf, pg. 2-1 and 3-1, 3-2). If each plane on average sorties ~1 time per day in the squadron for 30 days (480 sorties), and 25% become mission non-capable (4 aircraft), this is an attrition rate of .83% per sortie for the first 30 days. *Note this is very much a first order approximation.*

So, we can subtract out these losses per sortie (assuming again that there was 1 sortie per aircraft in the squadron TOE) to get the following:

Squadron Attrition Rate from Combat by Aircraft Generation Assuming a Variety of Missions		
	Average Kills	Average Losses
5th Gen vs. 5th Gen	1.6%	1.6%
5th Gen vs. 4th Gen	11.6%	1.6%
4th Gen vs. 4th Gen	6.6%	6.6%

Is this realistic? First note that this assumes 16-18 aircraft-sorties per day (e.g. each squadron generates 16-18 aircraft to fly a sortie at various points in the day), and that only 50% of sorties get into a fight. The numbers will change if you change the assumptions.

Second, let us gut check the numbers. Stealth aircraft are taking very low losses per sortie, with stealth doing very good against 4th Gen, and 4th Gen aircraft (lacking the defensive value of stealth) hitting each other

pretty hard. Regardless of a specific quibble over the numbers (10% vs. 8% vs. 13%) these seem to fall within what could happen (we do not really have good numbers to compare to!).

Second, in *The First Battle of the Next War Wargaming a Chinese Invasion of Taiwan* (Mark F. Cancian, Matthew Cancian, and Eric Heginbotham, January 2023, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/230109_Cancian_FirstBattle_NextWar.pdf?VersionId=WdEUwJYWIySMPIr3ivhFolxC_gZQuSOQ), it is stated that "historical attrition rate per sortie in most conflicts is less than 1 percent, and only 2 percent for the particularly intense Battle of Britain" (pg. 41). Why do my numbers differ? I think this is for two main reasons. First is that historical rates do not account for the very long range modern BVR combat and increased number of sensors in the air. Second, it does not account for modern IADS systems with their networked sensors and improved SAMs.

Difference from Historical Squadron Attrition Rate from Combat by Aircraft Generation				
	1% Attrition Difference		2% Attrition Difference	
	Average Kills	Average Losses	Average Kills	Average Losses
5th Gen vs. 5th Gen	0.6%	0.6%	-0.4%	-0.4%
5th Gen vs. 4th Gen	10.6%	0.6%	9.6%	-0.4%
4th Gen vs. 4th Gen	5.6%	5.6%	4.6%	4.6%
Avg. Attrition Difference	3.93%		2.93%	

Furthermore, higher loss rates per sortie are possible. In the Battle of Kursh, the Soviet Air Force from 5 July to 8 July made 11,235 sorties with combat losses of 556 aircraft meaning 4.95% losses per sortie (see https://en.wikipedia.org/wiki/Operation_Citadel accessed January 16th, 2024, citing G.A. Koltunov and B.G Solotiev, (Kurskaya Bitva, p. 366 16-ya Vozdusnye Sily v Volykoy Otechestvennoy Voyne p. 186), which I cannot find to read myself)

[70] This is representing the fact that multirole aircraft are designed to be better able to conduct air-to-air missions than non-multirole aircraft and can defend themselves much better. For example see discussion here: *F-15E: Flying The F-15E Strike Eagle In Air-To-Air Combat, From Dogfighting To Drone Hunting*, Thomas Newdick, Jul 1, 2024, https://www.twz.com/air/f-15e-strike-eagle-in-air-to-air-combat-from-dogfighting-to-drone-hunting.

[71] **The Attributes of Different Aircraft**

The modifiers here result in 5th Gens that are more survivable than lethal (but good at both) and cannot be scratched by 3rd Gens. 4th Gen is the middle of the road, and 3rd Gens are useless (they can only scratch 5th Gen if there is a 5th Gen squadron supporting them). Generally informing the value of different generations of aircraft (see the last 1/4th of the piece for a general overview): https://www.thedrive.com/the-war-zone/26880/enough-with-the-indian-mig-21-bison-versus-pakistani-f-16-viper-bullshit. Note the lack of a modifier for one side or the other based on quality of pilots is due to these rules assuming all sides are of equal capability. An alternative view on force quality may be found at *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, published 2015, Heginbotham et. al., pg. 80-81.

In terms of comparison for the numbers laid out in the rules to other data see *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, published 2015, Heginbotham et. al. On pg. 82 is presented lethality and vulnerability numbers for aircraft. A comparison to the numbers of this game follows:

Numbers have had the force quality degradation removed to allow for assessment of the aircraft only. Note that the report calls out several other assumptions the numbers make.

RAND Scorecard Original Numbers		
	Lethality	Vulnerability
2nd-3rd Gen	0.14	2.42
4th Gen	2	0.7

5th Gen	2	0.1

The numbers are then normalized to be equal to be a value between 0-1.

RAND Scorecard Normalized Numbers		
	Lethality	Vulnerability
2nd-3rd Gen	0.07	1
4th Gen	1	0.29
5th Gen	1	0.04

I am not sure of what exactly the variables in the report represent so I have to assume, but the normalized numbers for the given air-to-air engagement and modifiers in these rules are presented:

Rules Normalized Numbers		
	Lethality	Vulnerability
2nd-3rd	0.33	1
4th	0.60	0.67
5th	1	0.13

The difference between the two sets:

Difference Between Normalized #'s		
	Lethality	Vulnerability
2nd-3rd*	0.26	0
4th	-0.4	0.38
5th	0	0.09

*Note the rules only have 3rd gen, but the RAND report has 2nd-3rd gen. As such, the comparison here may be skewed.

Note that given the fact that the Report's numbers come from 4 on 4 head on engagements without enablers, and as per the previously cited Drive piece at the start of this footnote, I feel that this scenario undervalues the effectiveness of properly upgraded lower generations of aircraft. There are a number of reasons I value stealth less:

1) More investments have occurred in anti-stealth technologies which mitigates some of their effect.
2) A desire not to include stealth as a "Wunderwaffe" in games as it leads to sloppy planning and thinking from teams ("the bomber/stealth aircraft always gets through"),.
3) Enablers were not included in the report (AWACS, ground radar, etc.) would help to mitigate the effects of stealth.
4) The modeling scenario in the report is a head on approach 4 vs. 4 which overvalues the effectiveness of stealth aircraft as per point 3 and also as many (F-35 and J-20) optimize their front on RCS, and as it means that more complex anti-stealth tactics like having a group to jump the stealth aircraft after they are engaged/have been revealed by firing can't be used.
5) Other effects like EW, C2 degradation, munitions shortfalls, ISR degradation, tanker aircraft degradation, etc. that reduce the overall effect of stealth fighters in sum, but much less as individuals (therefore being missed by the modeling).

As for the differences in 4th Gen lethality/vulnerability, I think part of the difference can be accounted for by a lack of enablers in the Report's study, though not all of the difference can. I maintain the +0/+0 here therefore for the ease of control in adjudication as 4th Gen aircraft are the most numerous and adding more modifiers would slow down the air combat resolution dramatically. If you wish to include, add +1 to the attack modifiers of 4th generation aircraft all the time (it is currently only added against 5th Gen as a way to keep the system simple but still have 4th Gen able to damage 5th Gen). That modification would produce the following table (this table is currently outdated):

4th Gen +1 Normalized Numbers

	Lethality	Vulnerability
3rd	0.39	1
4th	0.67	0.78
5th	1	0.17

Other sources from which I draw views on this subject are:

- *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, published 2015, Heginbotham et. al., pg. 108 for intercept ranges as informing some of my views.
- *Air Defense Options for Taiwan, An Assessment of Relative Costs and Operational Benefits*, Lostumbo et. al., RAND, 2016, particularly pg. 36 (value of 4.5th Gen), the table on pg. 44 (aircraft lethality), 44-45 (value of 4.5th Gen), 48-49, 107 (figures on pages 104 and 106 are reproductions) (aircraft survivability), 100-101 (aircraft lethality/survivability). Note that on pg. 100-101, they provide estimates of various aircraft effects, but I weight these as lower than The US-China Military Scorecard due to the considerations noted by the authors on pgs. 97-99 and 101-102. Much the same for exchange ratios presented on 105.
    - Aircraft generation effectiveness findings from the report. The averages should be considered extremely rough first order approximations due to how the numbers were derived (expert estimates).

F-35 Effectiveness Compared to F-16C/D or V (4.5th Gen Fighter)				
Page # For Info	Lethality	Survivability	Overall	Vs.
105			4	2016 PLA Capabilities
107			5.6	Projected PLA Capabilities
48 or 104		1.35		2016 PLA Capabilities
49 or 106		1.8		Projected PLA Capabilities
100	1.14	6 or 3.5		2016 PLA Capabilities
101	1.19	2.5		Projected PLA Capabilities
44	3.7+ (V) 9.3+ (C/D)			2016 PLA Capabilities
Average	3.8325	3.03	4.8	

Numbers are expressed as wholes (4 times better, 1.14 times better than 4.5th Gen)

F-35 Effectiveness Compared to F-16A/B (4th Gen Fighter)				
Page # For Info	Lethality	Survivability	Overall	Vs.
105			15.3	2016 PLA Capabilities
107			15	Projected PLA Capabilities
48 or 104		1.65		2016 PLA Capabilities
49 or 106		3		Projected PLA Capabilities
100	1.39	13 or 5.25		2016 PLA Capabilities
101	1.47	3.4		Projected PLA Capabilities
44	15.5+			2016 PLA Capabilities
Average	6.12	5.26	15.15	

F-16C/D or V (4.5th Gen Fighter) Effectiveness Compared to F-16A/B (4th Gen Fighter)				
Page # For Info	Lethality	Survivability	Overall	Vs.
105			3.5	2016 PLA Capabilities
107			3	Projected PLA Capabilities
48 or 104		1.26		2016 PLA Capabilities
49 or 106		1.5		Projected PLA Capabilities
100	1.15	2.16 or 1.5		2016 PLA Capabilities
101	1.24	1.36		Projected PLA Capabilities
44	4.17 (V) 1.7 (C/D)			2016 PLA Capabilities
Average	2.065	1.556	3.25	

As the rules do not model differences between 4th Gen and 4.5th Gen (I assume in these rules that there are a mix of both to the point where it is a wash), we can compare the 5th Gen vs. 4th Gen numbers directly.

5th Gen vs. 4th Gen	Lethality (X times more Lethal)	Survivability (X times more Survivable)
Rules	1.6	4.3
RAND Air Defense (4th G)	6.12	5.26
Difference	-4.52	-0.96

These numbers are only slightly closer when (as the rules assume) we assume that "4th Gen" are a combination of 4th and 4.5th Gen aircraft.

5th Gen vs. 4th Gen	Lethality (X times more Lethal)	Survivability (X times more Survivable)
Rules	1.6	4.3
RAND Air Defense (4th/4.5 th G)	4.97625	4.145
Difference	-3.37625	0.155

Note major differences here between the rules and the RAND Air Defense report. As these numbers were derived from expert sentiments, I default substantially more heavily towards the RAND Scorecard numbers, with my caveats to their methodology spelled out above.

[72] The value here is drawn from a talk by a F-35 pilot about F-35 employment and tactics at Red Flag, which I cannot find the reference for.

- *Maximum Value from the F-35: Harnessing Transformational Fifth-Generation Capabilities for the UK Military*, Justin Bronk, Febuary 2016, https://static.rusi.org/20160201_whp_maximum_value_from_the_f-35_web.pdf

For an illustration of how it might work, see a good description of the Indian use of Su-30K's in Cope India 2004, (https://www.thedrive.com/the-war-zone/26880/enough-with-the-indian-mig-21-bison-versus-pakistani-f-16-viper-bullshit, 2019) where one plane picks up information for the others then datalinks it to them allowing them to shoot, the inherent stealth of the F-35 makes it better for this than other aircraft. The point the pilot made was that the F-35 had a unique capability for data collection, fusion, and transmission. For further evidence of this sort of quarterbacking see https://www.thedrive.com/the-war-zone/f-35s-keep-f-16s-in-the-fight-during-northern-lightning

Note that both F-22's and J-20's seem to have datalinks, but the F-35's sensors + the datalink are the key reason this is a F-35 exclusive ability. As of 2022ish, F-22 Raptors also have datalinks ability as well with their new R1 upgrade (https://www.thedrive.com/the-war-zone/f-22-raptor-being-readied-for-aim-260-missile-by-green-bats-testers, 2022) though I have not seen an example of them doing this sort of "quarterbacking" (though this may well be due to me missing it), and it seems likely that the J-20 has a

datalink (https://airpowerasia.com/2020/08/15/chengdu-j-20-overhyped-or-reality-a-comprehensive-story/, 2020). Given the lack of information on the abilities of the J-20 compared to Western 5th Gen aircraft, I do what I have done through the rules and rate it in these rules as being equivalent (see this article for further discussion on how good J-20's may be: https://www.thedrive.com/the-war-zone/air-force-generals-arent-losing-sleep-over-chinas-j-20-stealth-fighter, 2022).

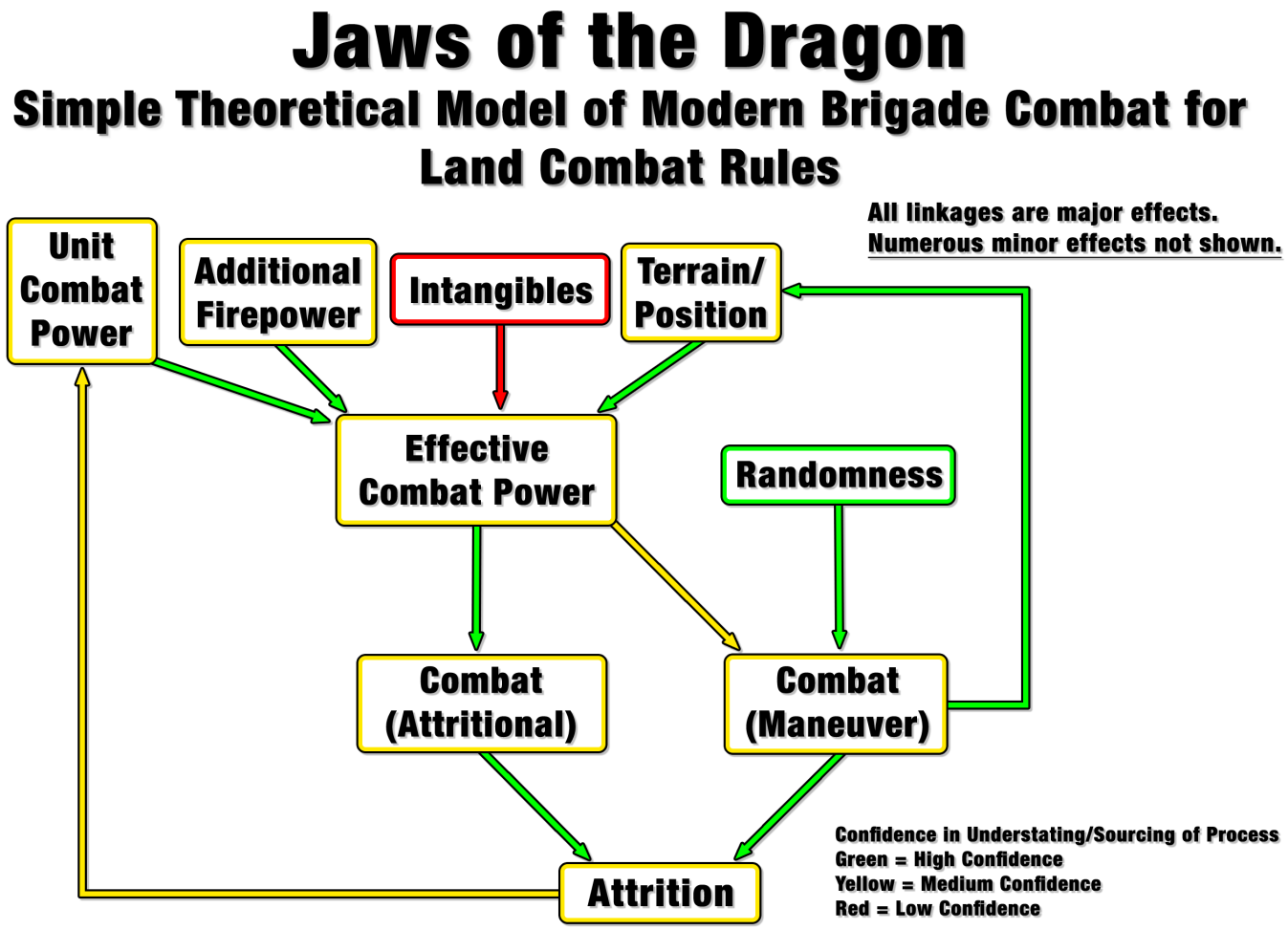
[73] See above for a discussion of why 4th Gen are +0/+0 for the most part, but having this +1 allows them to damage the otherwise invincible -3 5th Gen aircraft without having to add a lot of complexity by having a constant +1.

[74] Unit movement is based on numbers from *TRADOC Pamphlet 350-14, Heavy Opposing Force (OPFOR) Operation Art Handbook,* September 1994, or if that does not provide the desired information numbers from Warfighter 2 Remote by Maj. Tom Mouat MBE.

[75] SDDCTEA PAMPHLET 700-2 Logistics Handbook For Strategic Mobility Planning, Military Surface Deployment And Distribution Command, 2011, https://www.sddc.army.mil/sites/tea/functions/deployability/deployabilityanalysis/key%20publications/pam_700-2.pdf, Load/Unload times: Table 6 on pg. 56. Assumes sufficient ships are available for use.

[76] Land Combat (General Information)

This is the general theoretical model of the land combat rules:



The central thesis of this model is that attrition taken by forces is the ultimate factor in land combat. This can be inflicted in a number of ways and is influence by a myriad of factors, but the loss of equipment, personal, and their summative system is the ultimate factor of the battlefield.

The best argument against this model is that the effect of morale, troop quality, and command and control is not well modeled in the system and is assumed to be equal between all forces. System destruction warfare or

imposing psychological impact leading to the collapse of the enemy is not possible with this system, except by doing so to the human opponent playing.

The following pieces generally inform this section. Note while there are piles of stuff in here on the Russian Invasion of Ukraine, I am very careful in trying to understand where things would apply to the Taiwan fight and where they would not.

- Books
    - *How to Make War,* 4th Edition, James F. Dunnigan, 2003
- Experts
    - Various Experts on the Russian Invasion of Ukraine – Particularly Michael Koffman, Rob Lee, Dara Massicot, RUSI (Jack Watling and Nick Reynolds), Konrad Muzyka, and Tatarigami (as well as a host of others).
    - On the theory of warfare (in no particular order or agreement with their positions): Franz-Stefan Gady, Amos Fox (with whom my philosophical disagreements are of great use in understanding my own ideas), and Jack Watling. Others: Michael Koffman, Mick Ryan, and Lawrence Freidman.
- RUSI Papers on the Invasion of Ukraine
    - *Preliminary Lessons from Ukraine's Offensive Operations*, 2022–23, Jack Watling, Oleksandr V. Danylyuk, and Nick Reynolds, 2024, https://static.rusi.org/lessons-learned-ukraine-offensive-2022-23.pdf
    - *Meatgrinder: Russian Tactics in the Second Year of Its Invasion of Ukraine*, Jack Watling and Nick Reynolds, RUSI Special Report, 19 May 2023, https://static.rusi.org/403-SR-Russian-Tactics-web-final.pdf,
    - *Stormbreak: Fighting Through Russian Defences in Ukraine's 2023 Offensive*, Jack Watling and Nick Reynolds, September 2023, https://static.rusi.org/Stormbreak-Special-Report-web-final_0.pdf
    - *Tactical Developments During the Third Year of the Russo–Ukrainian War*, Jack Watling and Nick Reynolds, February 15th, 2025, https://static.rusi.org/tactical-developments-third-year-russo-ukrainian-war-february-2205.pdf
        - For a good discussion on a specific example of the "Attrition in Depth" strategy described by Watling and Reynolds, see *Ukrainian Abwehrschlacht: Defense in Depth in Modern Warfare, Dispatches from the Frontline and Lessons Learned,* Secretary of Defense Rock*,* Mar 12, 2025, https://secretaryrofdefenserock.substack.com/p/ukrainian-abwehrschlacht-defense?r=376i7r
- RUSI Papers on Warfare
    - RUSI Occasional Paper, *The Future of Fires: Maximising the UK's Tactical and Operational Firepower*, Jack Watling, November 2019, https://static.rusi.org/op_201911_future_of_fires_watling_web_0.pdf
    - *Heavy Armoured Forces in Future Combined Arms Warfare*, Nick Reynolds, RUSI Occasional Paper, 12 December 2023, https://rusi.org/explore-our-research/publications/occasional-papers/heavy-armoured-forces-future-combined-arms-warfare
    - *Mass Precision Strike: Designing UAV Complexes for Land Forces*, Justin Bronk and Jack Watling, RUSI Occasional Paper, 11 April 2024, https://static.rusi.org/mass-precision-strike-final.pdf
- Discussion from the National Training Center
    - *Preparing to Win the First Fight of the Next War,* Feb 23, 2024, Maj. Gen. Curt Taylor, https://mwi.westpoint.edu/preparing-to-win-the-first-fight-of-the-next-war/

- *Preparing Your Unit to Win the First Fight of the Next War*, March 1st, 2024, Maj. Gen. Curt Taylor, https://mwi.westpoint.edu/preparing-your-unit-to-win-the-first-fight-of-the-next-war/.
- *Thinking Inside the Box – The Gauntlet*, https://www.dvidshub.net/podcast/574/thinking-inside-the-box-the-gauntlet.

- Operational Research (Historical Analysis)
  - *The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, edd. John Curry, 2nd Edition (Hardback), 2023
  - *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017
  - *Understanding War*, Trevor N. Depuy, Paragon House, 1987, ISBN 0-913729-57-4
- Other Studies
  - The excellent discussion of breakpoints and attrition in *Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces*, Maj. Daniel Clevenger, March 1997, pg. 16-25.
- Other Works
  - https://wavellroom.com/2022/10/12/a-river-too-far-control-of-bridges-in-kherson-oblast/

[77] **Combat Power**

For the purposes of this game combat power is defined as "the ability to punch the other person in the face and the ability to keep going when you get punched." Functionally combat power is your ability to fight and continue fighting despite taking damage.

Combat power is calculated by using the Force Equivalent numbers from (the download takes some time to load properly) https://rdl.train.army.mil/catalog/view/100.ATSC/CE5F5937-49EC-44EF-83F3-FC25CB0CB942-1274110898250/aledc_ref/cas3_force_ratio_calc.xls which are based on CGSC ST 100-3, Back Cover, an alternative download can be found as the *CAS3 Force Ratio Calculation Worksheet* at https://rdl.train.army.mil/catalog-ws/view/100.ATSC/CE5F5937-49EC-44EF-83F3-FC25CB0CB942-1274110898250/aledc_ref/index.htm. I am unable to find any information on how these were calculated.

I make one change to the given numbers, which is that I treat the effectiveness of helicopters as 1/3rd of the given value. This is for three reasons:

Brittleness of armor – war by numbers p.g 91, difference between armor loss on attack and defence. " armor losses tend to be farm more variable than personnel losses and very situation-specefic." – that's a goodl argument for randomness in the attrition. Potnelty also an arugment for higher levels of attriton given the prelvence of anti-armor weapons down to the suqad level with Depuy data from WW2 (or even later, 73 war maybe excepted, and 1991 not counting as the Iraqi RPG's and tanks were shit and not employed choesivily) dosent really account for. Understanding war pg 173, 179

Perhaps brittlness is the worng word. It is plastic with a distinct memotry. It deforms quickly, but then will spring back.

Non brittlenesss of aritlery?.- Understanding war pg 179

1. This is based on combat performance in Ukraine and the evolving trends against helicopters (see *The Arms of the Future*, Jack Watling, 2023, ISBN 978-1-3503-5295-7, https://www.bloomsbury.com/uk/arms-of-the-future-9781350352988/, pg. 162-163). Helicopters can be very vulnerable, and when committed poorly can take high losses (see the 2003 attack on Karbala, though notably most of the helicopters were damaged and returned to base, not destroyed, https://en.wikipedia.org/wiki/2003_attack_on_Karbala). In Ukraine helicopters have seen effective use from the Russians with long range standoff ATGM's on the defensive (see *Stormbreak: Fighting Through Russian Defences in Ukraine's 2023 Offensive*, Jack Watling and Nick Reynolds, September 2023, https://static.rusi.org/Stormbreak-Special-Report-web-final_0.pdf, pg. 17), and the Russians have seen some use with using them to break up attacks using lofted unguided rockets (see *Meatgrinder: Russian Tactics in the Second Year of Its Invasion of Ukraine*, Jack Watling and Nick Reynolds, RUSI Special Report, 19 May 2023, https://static.rusi.org/403-SR-Russian-Tactics-web-

final.pdf, pg. 22-23). The Ukrainians have also employed this lofting tactic, but to unknown effect. However, both Ukrainians and Russians have not to any large degree use helicopters in an standard "attack" role, even during more mobile phases of the war to my knowledge. This is, more or less because neither side has air superiority. If one has the ability to suppresses or destroy SHORAD and MRAD in volume, we can see helicopters being extremely effective (look back to the gulf war again). However, my assessment is that neither side will have sufficient air superiority to use helicopters at their maximum potential, as even if the Chinese are able to win air superiority over Taiwan, the number of MANPADs will still be a problem.

2. The vulnerability is not just confined to Ukraine, but also occurs in exercises. It is indicative that 72 hours is required for sufficient shaping for the effective employment of attack helicopters. *The Arms of the Future*, Jack Watling, 2023, ISBN 978-1-3503-5295-7, https://www.bloomsbury.com/uk/arms-of-the-future-9781350352988/, pg. 162-163
3. Rotary wing aviation when engaged by ADA is reduced in effectiveness by 25% (Dale Spurlin and Matthew Green, "Demystifying the Correlation of Forces Calculator," *Infantry*, (January-March 2017), https://www.moore.army.mil/infantry/magazine/issues/2017/JAN-MAR/pdf/7)Spurlin_CoFCalculator_txt.pdf). Given evidence from Ukraine (everyone's helicopters stay well back from the front line) this is likely generously low, and as my general assumption is that there are going to be a lot of MANPADS about at a minimum, helicopters are probably going to be very consistently engaged. This seems to be the case in Ukraine (*The Arms of the Future*, Jack Watling, 2023, ISBN 978-1-3503-5295-7, https://www.bloomsbury.com/uk/arms-of-the-future-9781350352988/, pg. 162-163)
4. Also note that in this game there is no consideration made for the effects of weather on operations. Limited visibility (rain, fog, etc..) would limit effectiveness by 25% (Dale Spurlin and Matthew Green, "Demystifying the Correlation of Forces Calculator," Infantry, (January-March 2017), https://www.moore.army.mil/infantry/magazine/issues/2017/JAN-MAR/pdf/7)Spurlin_CoFCalculator_txt.pdf), but given the already low-combat power and fragile nature of these units, (and I doubt that they would be highly committed in less than optimal conditions, mostly committed only if breakout was threated or break-in was required), it is to much effort and work control to apply the 25% reduction in combat power.

For a discussion on the validity of the CGSC numbers see:

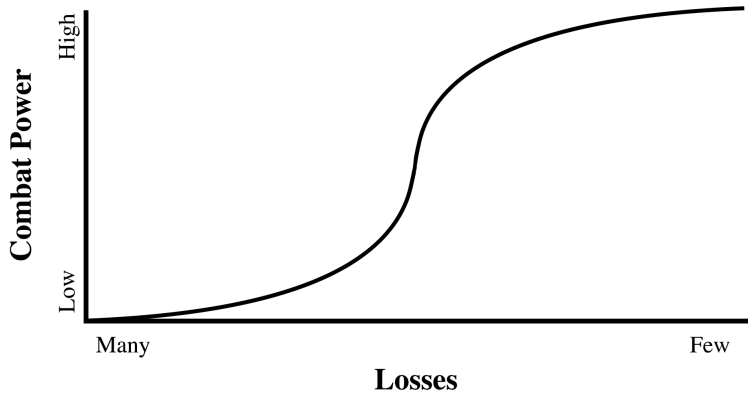
- Dale Spurlin and Matthew Green, "Demystifying the Correlation of Forces Calculator," *Infantry*, (January-March 2017), https://www.moore.army.mil/infantry/magazine/issues/2017/JAN-MAR/pdf/7)Spurlin_CoFCalculator_txt.pdf. The second page directly talks about this available version (the old one, as opposed to the updated version), of which the main problem was that some forces were too outdated. Thankfully for us, the Taiwanese use lots of outdated equipment, and there is enough modern equipment to make it more or less work for us (and if anything, this results in assuming that Chinese equipment and forces are better than they likely are, which I am fine with (better to train against a strong enemy than an weak one)).
- https://www.dupuyinstitute.org/blog/2017/12/07/how-does-the-u-s-army-calculate-combat-power-%C2%AF_%E3%83%84_-%C2%AF/. While this piece concludes that the combat power modeling is opaque and may be incorrect, lacking a better method to use than my own estimations I use the CGSC numbers (to see what the process of coming up with your own numbers looks like see: *Combat Power and Attrition Estimation (CPAE), Unit Combat Power Value Assessment*, Paul Works, Tyler Hitter, Michael Laquet, 15 June 2023, Presentation at Connections 2023, https://drive.google.com/file/d/1ZixTqnAT4nZJQSAcu_E3ibAZ4NjTktMa/view).
- An Examination of Force Ratios, Maj. Joshua Christian, School of Advanced Military Studies, 2019 https://apps.dtic.mil/sti/pdfs/AD1083211.pdf, pg. 28-30

Also note a key assumption of this game that the relationship between attrition and combat power is linear, and represented thusly in the rules, though a unit being "destroyed" by loss of all combat power is probably not the total wipe out of all people in a unit, but rather falling below the point of having any amount of combat power. This linear representation is probably incorrect as:

1. Units are a system, not individual summative packets of combat power. As losses occur the system breaks down rendering the overall whole less effective
2. Units take losses in their best troops, leaving more over time who are not as heroic.

a. Note heroic performance may well extremely important in determining combat outcomes (*The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023), and that while the proportion of people who don't participate in infantry attacks at all starts at ~6% (and lessened participation a higher % of troops, varying by study examined) it grows over time as others get killed (for the 6% number and a very good overview of the research see *Surveying the Spectrum of Human Behaviour in Front Line Combat*, Rowland, D., and L. R. Speight, Military Operations Research, Volume 12, Issue 4, 2007, http://www.jstor.org/stable/43941089, pg. 54-55). Note the data used by Rowland is WW2 data, and I suspect the numbers would be different in the categories of troop weapon use/activity compared to today and compared with volunteer armies. This may be seen to a certain degree in Cawkill's data looking at (presumably) the Falklands (pg. 57), though the comparison between the two datasets is imperfect (also due to the fact that the unit's sent to the Falklands were elite units).

I would theorize that this relationship between attrition and combat power probably looks like this. With the loss rate of combat power tapering off at the end as the system is already so broken that losing another piece has relatively little effect. The midpoint here is difficult to know, but one number for it is 37% losses in a unit (Dexter, Patricia. 2003. 'Combat Entropy as a Measure Of Effectiveness'. Journal Of Battlefield Technology 6 (3): 33–39., pg. 34-35)



Another proposed argument that matches the theoretical systems destruction one may be that entropy increases in the system due to casualties leads to this sort of combat power degradation. For this see work based on the ideas of Carvalho-Rodrigues:

- Carvalho-Rodrigues, F. '*A Proposed Entropy Measure for Assessing Combat Degradation*'. *The Journal of the Operational Research Society,* 40, no. 8 (August 1989), pg. 789–93 (see pg. 790 especially)
- Carvalho-Rodrigues, F., John T. Dockery, and Alexander E. R. Woodcock. '*Entropy in Combat Data'*, 1991. https://www.fernandocarvalhorodrigues.eu/PDF's/entropia/pdfs%20_entropia/Entropy_in_Combat%20Data.pdf.
- Dexter, Patricia. 2003. 'Combat Entropy as a Measure Of Effectiveness'. Journal Of Battlefield Technology 6 (3): 33–39., (pg. 34-35)

Why are Forces Assumed to be of Equal Quality/Effectiveness?

The other major assumption is that all forces are relatively equal in effectiveness of units and soldiers (e.g. one Taiwanese soldier is as effective as one US solider as is one Chinese soldier). This is a big assumption but is made for ease, as assessing differences is extremely difficult, and as I would rather have China be more competent adversary than a less competent one in this game. Note that there are many factors that can effect the combat value of troops, but generally this provides a value at maximum of one of your soldiers being worth 2 of the enemies. For more on this see: *Understanding War*, Trevor N. Depuy, Paragon House, 1987, ISBN 0-913729-57-4, pg. 105-123 AND *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 19-59.

Beyond even having quality soldiers the nature of their employment by their commanders might affect their relative effectiveness. For example Chinese brigades have 2 more battalions than a comparable US brigade,

which might be over the regular span of command for a brigade commander and thus lead to elements of the brigade being employed less efficiently (see *Span of Control and the Operational Commander: Is It more than Just a Number,* Major William G. Pierce, CGSC Mongraph, 1991, https://apps.dtic.mil/sti/citations/ADA240178/). Note beyond just troop quality matters, as well, as comader quality affects how forces are brought into battle, "The skill and personality of a strong commander represent a significant part of his unit's combat power" (*Span of Control and the Operational Commander,* pg. 21)

[78] **What is Attrition?**

Attrition is defined as "the depletion or destruction of an adversary's equipment, personnel and resources through a 'methodical use of battle or shaping operations' at a rate faster than the adversary can replace its loses" (Gady, Franz-Stefan. 2021. "*Manoeuvre Versus Attrition in US Military Operations*." Survival 63 (4): 131–48. doi:10.1080/00396338.2021.1956195., pg. 1). Here attrition can be considered a combination of KIA, WIA, morale, equipment losses, supply issues, C2 degradation, unit quality degradation, etc. (see *The Relationship of Battle Damage To Unit Combat Performance*, Leonard Wainstein, 1986, Institute for Defense Analyses, specifically pg. 2 and pg. 11-12 for several of these attritional factors). Thus, small attritions (represented as attrition) add up to the point (represented as points of damage) where rotating the unit out of combat doesn't fix the problem without long periods to reconstitute combat power.

[79] This number is a guess. The inability to replace damage represents key, unreversible degradation of the unit due to losses (requiring regeneration), where attrition can be repaired as it is lower level and requires reorganization (≠ regeneration). For further details see *ATP 3-94.4 Reconstitution Operations*, May 2021. https://armypubs.army.mil/epubs/DR_pubs/DR_a/ARN32296-ATP_3-94.4-000-WEB-1.pdf. Obviously, this is a loose rule of thumb and there are many exceptions to this where damage could be repaired, in such cases use professional judgement to come to a conclusion. The inability of artillery and helicopters to regenerate is due to their low number of systems and the specific role of the systems making them harder to replace (artillery and helicopter units), and the training required for personal being high (for pilots, and to some degree forward observers, etc..). This is more pertinent to helicopters than artillery, and Chinese forces could regenerate some of these losses from other units in non-engaged theater commands. If numbers are required the Chinese (and US *if* they have a good supply line into the area) can regenerate helicopters and artillery units: 7 days for artillery and 14 days for helicopters to remove 1 attrition, but these numbers are guesses on how long it would take to do the administration to ship the required pieces of equipment and crew and support personnel to the unit and integrate them into it.

While some have predicted the "death of the helicopter" as a result of the 2022 Russian invasion of Ukraine, I view this as not wholly correct. While helicopters may struggle against a well-constructed IADS, they can be effective against uncovered maneuvering forces as occurred during the 2023 Ukrainian Counteroffensive (see *Stormbreak: Fighting Through Russian Defences in Ukraine's 2023 Offensive*, Jack Watling and Nick Reynolds, September 2023, https://static.rusi.org/Stormbreak-Special-Report-web-final_0.pdf, pg. 17), and as discussed in a NTC anecdote (*Preparing to Win the First Fight of the Next War*, Feb 23, 2024 Maj. Gen. Curt Taylor, https://mwi.westpoint.edu/preparing-to-win-the-first-fight-of-the-next-war/).

[80] **Why can Units be Ground all the Way Down in this Game?**

Exact percentages for units to become ineffective are not accurate (see *Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*, Dorothy K. Clark, Operations Research Office, Technical Memorandum ORO-T-289. Chevy Chase, 1954., https://apps.dtic.mil/sti/tr/pdf/AD0059384.pdf, pg. 3, 7-8). That said, abstractions and quantifications for the purpose of building a game model must be made.

This view of units remaining effective in combat even when ground down to a much lower number than classically assumed to make a unit "combat ineffective" is based on of *The Relationship of Battle Damage To Unit Combat Performance*, Leonard Wainstein, 1986, Institute for Defense Analyses as well as *Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*. See also *Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces*, Maj. Daniel Clevenger, March 1997, https://apps.dtic.mil/sti/citations/ADA331762, pg. 24, on the effects of a "combat ineffective" unit still being able to influence the battle.

These arguments seem to be at least somewhat borne out by descriptions of battalions in Ukraine still fighting at ~20% (40 of 200 TOE troops) or 35% strength (https://www.washingtonpost.com/world/2024/02/08/ukraine-soldiers-shortage-infantry-russia/), or a brigade at 40% infantry (https://www.pravda.com.ua/eng/articles/2024/09/17/7475408/). See also the excellent discussion of breakpoints and attrition in *Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces*, Maj. Daniel Clevenger, March 1997, https://apps.dtic.mil/sti/citations/ADA331762, pg. 16-25.

Note variance in real world outcomes here is likely to a bevy of factors, as well as the non-inclusion of breakpoints in this discussion. Functionally, there is an importance difference between a unit's ability to attack which is exhausted before it's ability to defend is. Clark *(Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*) defines these factors as follows:

1. Size of the unit (pg. 34)
2. Time over which the unit has take casualties (pg. 34)
3. Attrition – "Included may be growing awareness throughout the unit that casualties' have been heavy, accumulating memories of casualties witness by individual members of the unit, increasing apprehension among survivors as to their own fate, and accumulation of physical weariness and strain. One may also ask whether replacements represent a reinforcement in mental attitude, or whether they are instead very rapidly infected by the prevailing atmosphere of the unit, or if they in turn tend to degrade the effectiveness of the unit by their own inexperience and confusion." (pg. 16)
4. Ability of unit to take in new troops (e.g. number of old members of the unit remaining), (pg. 24)
5. Condition of troops at beginning of engagement (pg. 29-30) – this is comprised of:
    - Starting strength of the unit
    - Number of green troops
    - Unit experience (intensity of combat)
    - Unit experience (terrain)
    - Nature of their combat experience
    - Rest time before entering combat
    - Unit training as special troops (paratroops, etc..)
    - Training specific to the type of combat faced (e.g. river crossings)
6. Unusual environmental stress (pg. 30)
7. The imperative of the assigned mission (pg. 31)
8. Morale (pg. 31)
    - Troop mindset
    - Esprit-de-corps
9. Leadership (pg. 31)
10. Tactical plan (pg. 31)
11. Reconnaissance (either not knowing things important to planning or allowing the enemy to achieve surprise) (pg. 32)
12. Enemy opposition (pg. 32)
13. Fire support and reinforcement (pg. 32)
14. Logistical support (pg. 32-33)
15. Communications (both with subordinate and higher units). If communication is lost, leadership becomes more important. (pg. 33)

For a comparative look at what points a unit reaches combat ineffectiveness, given numbers are placed on the table below.

General Views		
Element	*Point of Unit Reaching Combat Ineffectiveness*	*Source*
US Army Views	15-30% casualties (tend towards 30%)	*Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces, pg. 17*
Schwarzkopf	30% casualties (ineffective, for offensive), 50% casualties ("really combat ineffective", ineffective for both offense and defense)	*Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces, pg. 21-22*
Artillery Views		
US Field Artillery Views	30% casualties in a short time span	*Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces, pg. 24*
Soviet Artillery Norms	30% casualties (ineffective for offensive), 50%-60% casualties (annihilation or destruction of unit)	*Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces, pg. 23*
Battalion		

Breakpoint Type I (Attack => Reorganization => Attack) - *General*	24.8% enlisted (12-38%), 21.5% (officers), casualties incurred over multiple days. Unit takes higher losses on day of breakpoint. One StDev from mean given in brackets. "The unit may be able to continue the attack after a few hours if more than half the losses are Incurred in a short time (no longer than 24 hours); otherwise it must revert to defense".	*Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*, pg. 17, 19-20
Breakpoint Type I (Attack => Reorganization => Attack) – *within 2-4 days from entering combat*	13-34% casualties (range is based on 1 standard deviation from the mean)	*Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*, pg. 34
Breakpoint Type I (Attack => Reorganization => Attack) – *within 6-11 days from entering combat*	20-30% enlisted, 27% of officers	*Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*, pg. 34-35
Breakpoint Type I (Attack => Reorganization => Attack) – *within 16/18-22 days from entering combat*	Does not occur	*Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*, pg. 35
Breakpoint Type II (Attack => Defense, forced to regenerate combat power) - *General*	27.6% enlisted (7-47%), 26% (officers), casualties incurred over multiple days, Unit takes higher losses across multiple days. One StDev from mean given in brackets.	*Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*, pg. 17, 19
Breakpoint Type II (Attack => Defense, forced to regenerate combat power) – *within 2-4 days from entering combat*	4-23% (range is based on 1 standard deviation from the mean)	*Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*, pg. 34
Breakpoint Type II (Attack => Defense, forced to regenerate combat power) – *within 6-11 days from entering combat*	20-30% enlisted, 27% of officers (includes replacements)	*Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*, pg. 34-35
Breakpoint Type II (Attack => Defense, forced to regenerate combat power) – *within 16/18-22 days from entering combat*	No data given.	
Breakpoint Type III (Defense => Ordered to withdraw to secondary line) - *General*	52.3% enlisted (37-69%), 46.4% (officers), casualties incurred over multiple days, Unit takes higher losses across multiple days. One StDev from mean given in brackets.	*Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*, pg. 19
Breakpoint Type III (Defense => Ordered to withdraw to secondary line) – *within 2-4 days from entering combat*	Does not occur	*Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*, pg. 34
Breakpoint Type III (Defense => Ordered to withdraw to secondary line) – *within 6-11 days from entering combat*	42-71% enlisted, 29-63% officers (range is based on 1 standard deviation from the mean, includes replacements)	*Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*, pg. 35
Breakpoint Type III (Defense => Ordered to withdraw to secondary line) – *within 16/18-22 days from entering combat*	8-17% enlisted, 5-11% officers (range is based on 1 standard deviation from the mean, these are net casualty rates (e.g. includes heavy replacements being added to the unit)	*Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*, pg. 35
Soviet Belief (Battalion)	35% casualties (ineffective for offense), 50% casualties (ineffective for defense, capable of fighting retreat only)	*Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces, pg. 23*
Ukrainian Experience	Battalion still fighting at ~20% or 35% remaining strength (65-80%+ casualties)	*Front-line Ukrainian infantry units report acute shortage of soldiers,* Isabelle Khurshudyan and Anastacia Galouchka, February 8, 2024, Washington Post

Ukrainian Experience	Battalion defending at around 10% strength	*'We Simply Had Ho One and Nothing Left to Fight With' — a Representative of the 72nd Brigade Battalion Headquarters on Leaving Vuhledar,* Настя Станко, October 2, 2024, https://www.slidstvo.info/english-stories/we-simply-had-ho-one-and-nothing-left-to-fight-with-a-representative-of-the-72nd-brigade-battalion-headquarters-on-leaving-vuhledar/
Russian Attack Usage (Nov. 2024, Jan. 2025).	Unit rotated out of frontline (units being used for continual small scale (section/platoon) infantry attack) at 30% casualties (e.g. unit has lost offensive potential and is swapped with a better unit). It is unclear if this belief is that the unit has loss offensive potential, or that diminishing marginal returns are beginning to occur however.	*Tactical Developments During the Third Year of the Russo–Ukrainian War*, Jack Watling and Nick Reynolds, February 15th, 2025, https://static.rusi.org/tactical-developments-third-year-russo-ukrainian-war-february-2205.pdf, pg. 8 Note that while pg. 8 is unclear if it is Rgmt. or Bn. rotating, pg. 17 is clear that Rgmt's are rotating their battalions.
Regiment		
Breakpoint: Attacker Forced into Defense Posture	4.3% casualties	*Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces, pg. 18*
Breakpoint: Defense Forced to Withdraw	14% casualties	*Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces, pg. 18*
Brigade		
Soviet Belief (Brigade), Lt. Col. Yuri Demerenko	50% losses of main weapon systems (ineffective for attack and hasty defense), 60% losses (ineffective for prepared defense)	*Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces, pg. 23*
Ukrainian Experience	Brigade still fighting at 40% strength (60% casualties)	*Infantry war at Pokrovsk: why Ukraine's key eastern front started (and continues) to crumble,* Olha Kyrylenko, 17 September 2024, Ukrainska Pravda
Division		
Soviet Belief (Division), Lt. Col. Yuri Demerenko	35% losses (ineffective for attack or defense)*	*Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces, pg. 23*
Breakpoint: Attacker Forced into Defense Posture	4.8% casualties	*Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces, pg. 18*
Breakpoint: Defense Forced to Withdraw	37% casualties	*Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces, pg. 18*
Other		
Breakpoint: Defense Forced to Withdraw	42-71% enlisted and 29-63% officer casualties.	*Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces, pg. 17*
Army Level Defense	"A study of casualties has indicated that the effectiveness of an army reaches a critical level when the number of casualties lies between 25 and 35% of the number of combatants. Beyond this point all efforts, no matter how heroic, will not be able to avert defeat. That means that a parameter which is useful for measuring combat degradation due to casualties must peak at around these percentages.", the measure of entropy as a function of casualties measured in the study peaks at 37%, and reaches 60% of it's peak at 10%.	Carvalho-Rodrigues, F. '*A Proposed Entropy Measure for Assessing Combat Degradation*'. *The Journal of the Operational Research Society,* 40, no. 8 (August 1989), pg. 790

***** "This update to Soviet thought is due to the higher level of complexity associated with combined arms operations at the division level, and modern sustainment requirements for heavy armored and mechanized units"

From *The Relationship of Battle Damage To Unit Combat Performance*, Leonard Wainstein, 1986, Institute for Defense Analyses, the most casualties units were able to reach and still complete their missions (typically defense) was 70% casualties.

[81] This is both convenient (½ is easy to calculate) and also seems to be borne out somewhat by Chinese experience in Korea, where twice the effort was required to match a well-supplied opponent (e.g. the unsupplied Chinese were ½ as effective as the well supplied opponents). I know that there are multitudes of

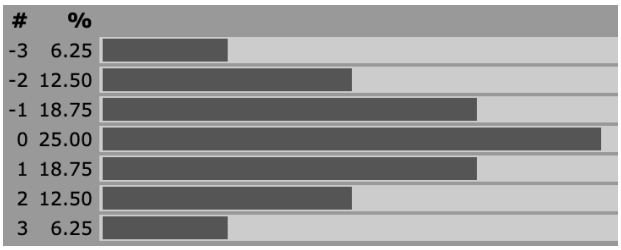
differences between the Chinese experience in Korea and today that muddy this comparison, but lacking other evidence currently, and with ½ being an easy number I use it here. See *How to Make War,* 4th Edition, James F. Dunnigan, pg. 500.

[82] **The Choice of d4's and Randomness**

I have not spent a long time thinking about the nature of dice, randomness, and what they represent in wargames. Thus, I would simply contend for now that they represent the following

a) Chance – the inherent randomness of opposed decisions and luck in fighting
b) Friction – the creation of mistakes and problems that are unavoidable. Friction is a functional negative (the best outcome of friction is no effect), while chance can be both a positive or negative, hence why I separate them.
c) Things not Modeled and Abstracted Away in this Model of Combat – there are physical and non-physical tools and effectors of war not present in the model of combat that could on occasion have significant effect on the outcomes of battle. These are below the level of representation of the game or abstract for playability, their effects are (as much as one can) felt here in the dice.
    a. Examples:
        i. Skilled leadership, Medical Treatment, Signaling, POW's

The use of a d4 here leads to some potential variability (+3/-3), though the use of two dice means that this is (approximately) a normal/Gaussian distribution. While some would argue about the accuracy of such variability in combat, I would note that combat is inherently complicated, confusing, and dependent upon a menagerie of different factors that make outcomes imprecise. Adding in such variability using the d4 system (a 62.5% chance of being inside the bounds of +1/-1, and an 87.5% chance of being inside the bounds of +2/-2), is less unrealistically "swingy" than might be initially presumed. Maj. Mouat also agreed with the use of a d4 for these rules as more realistic than a d6. The 1d4-1d4 distribution is as follows:



Variability of combat is somewhat informed by *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 11-12

[83] **The Two Types of Combat: Attritional and Maneuver**

This difference between attritional combat which slowly wears at units and maneuver combat which expends great numbers of men and material to achieve results (hence d6 as maneuver combat varies greatly in losses depending on distance, terrain, supply, and enemy resistance) allows for both types of warfare to be fought with these rules. Functionally I conceptualize attritional warfare, as slow moving where the objective is to inflict damage on the enemy, and maneuver warfare as an attempt to seize and hold ground. I am notably agnostic on the actions (and the philosophic centers of gravity they consequently target) taken to attempt to achieve these aims, I am solely interested in the descriptive differences between the two types of warfare.

For an indication of just how lethal maneuver warfare can be see Table 1, page 1 of *Our Readiness Problem: Brigade Combat Team Lethality*, LTC Bradford T. Duplessis, 2017, https://www.benning.army.mil/armor/eARMOR/content/issues/2017/Fall/4Duplessis17.pdf (though note as per *The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023, there is a 50-90% decrease in the effectiveness of weapons in real combat as opposed to exercises. Note my views of attritional warfare (though attrition does not just mean soldier and material loses at this level but also the burning up of supplies, fatigue, and other intangibles, see *The Relationship of Battle Damage To Unit Combat Performance*, Leonard Wainstein, 1986, Institute for Defense Analyses, specifically pg. 2 and pg. 11-12 for several of these attritional factors) as the opposite of maneuver warfare is heavily colored by the Russo-Ukrainian War and

World War II, nicely summed up by Michael Kofman's repeated statement that "attrition enables maneuver" (see Making Attrition Work: A Viable Theory of Victory for Ukraine by Franz-Stefan Gady and Michael Kofman, February–March, https://doi.org/10.1080/00396338.2024.2309068). Also interesting on this point is *Maneuver Warfare is not Dead, but it Must Evolve*, Col. Pat Garrett (Ret.), Lt. Col. Frank Hoffman (Ret), Proceedings, November 2023, pg. 26-31 (pg. 28-29 is the most interesting, but I do not wholly agree with the whole piece.) Note that there are theorists who would wholly reject this characterization of maneuver vs. attritional warfare by changing/challenging the colloquial US army definitions and asserting "positional warfare" ('*A Solution Looking for a Problem: Illuminating Misconceptions in Maneuver-warfare Doctrine*', Amos C. Fox, Armor, Fall 2017, https://www.moore.army.mil/armor/eARMOR/content/issues/2017/Fall/ARMOR_Fall_2017_edition.pdf). However, I view "positional warfare" as an element of attritional and maneuver warfare, and reject the idea that attritional attacks employed in support of maneuver make that attempt maneuver warfare "attritional warfare" instead. Furthermore, if positional warfare is to be conducted in this game, it is conducted by the position of units on the map in relation to the terrain, and thusly does not need to be covered as a separate type of combat here (e.g. the nature of positional warfare is combat agnostic, with combats within positional warfare being maneuver or attritional in nature). Consequently, even if one does not buy my argument about the nature of maneuver, attritional, and positional warfare, this game does represent all three.

[84] This correlation between casualty rates can be seen in *Understanding War*, Trevor N. Depuy, Paragon House, 1987, ISBN 0-913729-57-4, pg. 167-169, 175 (verity 3), 176 (verity 7). For example, see figure 13-1. For every 4% casualties taken by the loser of a combat, the winner takes 3% casualties. Thus I assume that the winner takes roughly 1 less than the loser. This is imperfect at best, but is the closet I can get with the way this system works. Furthermore given verity 8 and verity 12 (pg. 176, 177), and the nature of fighting on Taiwan (lots of prepared defenses, difficult terrain), I think in the case of the defender in both cases, and the attacker in the case of verity 12 can help resolve some of the imperfection.

[85] This means that all units take some level of casualties, e.g. a successful defender or attacker always takes some attrition, and also that additional units committed to the attack also take higher casualties as target density increases (for some evidence of this see *The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023, pg. 80).

[86] This is due to the fact that each individual piece of equipment generates a much higher combat value than in a regular unit. E.g., losing one piece of artillery or a helicopter loses much more combat power a single tank, IFV, infantryman, or truck.

[87] Maneuver attacks carry risk, attrition attacks are squeezing out the enemy and attrition, so no randomness. The person who is in the more favorable position is able to inflict a disproportionate amount of attrition to the enemy compared to the amount of attrition they take. Thus, the net effect of attrition is the difference between the attrition taken by both sides, which is an outcome of the available combat power (unit combat values) and effects of the terrain etc. (the column shifts). In terms of determining the upper bound of the ammout of attrition as a result of combat, see Table 1, page 1 of *Our Readiness Problem: Brigade Combat Team Lethality*, LTC Bradford T. Duplessis, 2017, https://www.benning.army.mil/armor/eARMOR/content/issues/2017/Fall/4Duplessis17.pdf. On lower bounds note that an attacking unit stops at around 5% casualties (*Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces*, Maj. Daniel Clevenger, March 1997, pg. 20), so even 1 or 2 attrition on a unit would be sufficient to stop its attack in most cases.

[88] **<u>The Construction of the CRT (Force Ratios and Outcomes)</u>**

Overall Construction

This combat results table is based on the DSTL Force Ratio Risk Table. Available at https://www.professionalwargaming.co.uk/Force%20Ratio%20Table%20with%20Numbers%20v0.1.png. Some minor modifications based on https://dupuyinstitute.org/2018/04/25/u-s-army-force-ratios/ (noting that this is WW2 data, and thus I think the chances of penetration is rather lower today), and https://dupuyinstitute.org/2017/09/19/human-factors-in-warfare-diminishing-returns-in-combat/ (note I include more ratios here beyond the "necessary" stated by Depuy as the randomness in the table is done via dice rolled column shifts across the table, so having the columns to allow shifts is important to the

functioning of the game. Those two Depuy Institute web pieces are the short versions. Read the books for more details.

Given the turn time of the game (1 turn = 1 day) I do not include hasty attacks as it would add another level of unnecessary complexity and uncertainty to adjudication and could cause players to argue if an umpire judged an attack to be hasty when players believed otherwise. Given the nature of fighting on Taiwan to include many dug-in positions, difficult terrain, and high force density around initial beachheads, I believe it likely that hasty attacks will not be especially efficient in taking ground and inflicting casualties (except perhaps on the attacker), thus meaning that they can be abstracted into prepared attacks that do have a larger effect on the battle without too much issue. Additionally, I am fine abstracting the difference between hasty defense (x1.3 effect on defender combat power) and prepared defense (x1.5 effect on defender combat power) as the difference here is realitivly minor in the large scheme of all the other effectors.

Outcomes

On the topic of outcomes (e.g. the effects of combat) on the table, these are grouped from possible levels of risk in the DSTL Force Ratio Risk Table. In assigning effects to the type of outcomes to the types of risk I generally go with a few things:

1. The general outcomes of combat are relatively consistent beyond a certain point due the law of diminishing marginal returns (e.g. a 10:1 force ratio does not advance 10 times further or inflict 10 times more casualties than a 1:1 force ratio). This is why large numbers of force ratios result in the same outcome (e.g. in a Meeting Engagement a 3:1 though 6:1 force ratio all result in "Defender Attritted"). This is supported by *Understanding War*, Trevor N. Depuy, Paragon House, 1987, ISBN 0-913729-57-4, pg. 125-147, 132 especially (combat outcomes) 154-157, 159-160 (advance rates), 177 (casualty rates). This is also tangentially discussed several times (mostly relating to casualties inflicted and force ratios and force ratios and rates of advance) in *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017.
2. All other factors being equal, the result of a 3:1 prepared attack against a prepared defense results in roughly equal chance of casualties on both sides (the actual amount of attrition is randomized as "equal casualties" represents the most likely outcome, but not the definite outcome). This means that attackers and defenders tend to take roughly the same number of casualties all other things being equal. This is roughly in line with the findings of *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 19-59 (see the number of casualties, but also the number of cases where the attacker lost ewer soldiers than the defender being higher than might conventionally be considered.

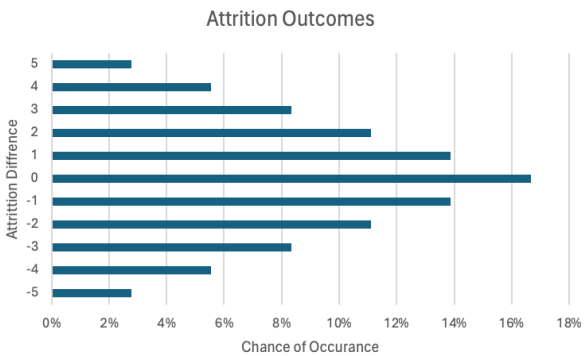


Figure 1 – Possible attrition outcomes from an exchange result between two units.

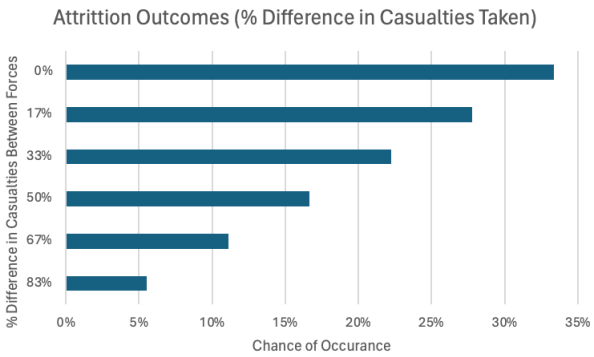


Figure 2 – Possible attrition outcomes as a % difference in casualties taken (between two units). This may seem rather high, but consider *Figure 3.*

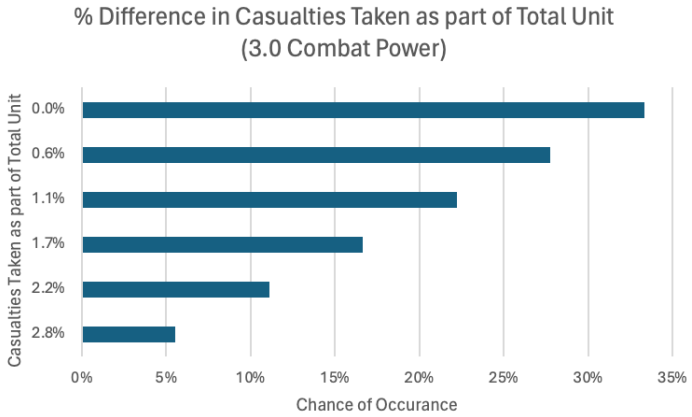


Figure 3 – Possible % differences in casualties taken as part of total unit combat power (assuming a 3.0 combat power) for a unit in an exchange result between two units. 3.0 is chosen as it's a good lower bound from most units in the game.

I then feel very comfortable anchoring "attacker attritted" at 1:1 force ratios due to the extremely low numbers given of successful attacks at less than 1:1 (see *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 19-59

3. Units take less damage before stopping the attack then expected (with the exception of breaching, where being caught in the breach can be deadly). See the breakpoint analysis section in *Effects of Air Interdiction Attacks on Advancing Armored and Mechanized Ground Forces*, Maj. Daniel Clevenger, March 1997, pg. 18-20. More or less units take ~5% casualties before halting an attack. Note here that I am quite comfortable allowing units to attack each day (e.g. previous day's battle results don't affect willingness to attack) as identified in work on breakpoints, particularly as high losses on one day are more easily absorbed than sustained losses. (see *Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion*, Dorothy K. Clark, Operations Research Office, Technical Memorandum ORO-T-289. Chevy Chase, 1954., https://apps.dtic.mil/sti/tr/pdf/AD0059384.pdf, pg. 17, 19-20) Note however, that after sustained time in combat rapid reorganization becomes much harder due to degradation across the force as opposed to heavy degradation of specific elements of the force. (pg. 23)
    - Note that Lawrences numbers suggests the following (see *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 65, 67, see also 146-160 for lower level unit attrition). Type of attack outcomes from Depuy Institute Databases are matched to game combat outcomes via casualty numbers (pg. 60-71) and via advanced rate (pg. 178)
    - WW2 Data (divisional and corps units):

Type of Attack	Limited	Failed	Advances	Penetrated
In Game	Attrition Combat	Attacker Attired Result	Exchange Result	Defender Attrited Result
Attacker % Casualties	.24	.80	2.98	1.20
Defender % Casualties	.20	.90	2.62	2.96

    - Post WW2 Data (up to 1991) for Battalion, Brigade, and Divisions, to be taken with a big grain of salt (the data is imperfect and limited in number)

Type of Attack	Limited	Failed	Advances	Penetrated
In Game	Attrition Combat	Attacker Attired Result	Exchange Result	Defender Attrited Result
Attacker % Casualties	.26	3.20	1.60	1.36
Defender % Casualties	.12	2.80	4.83	15.10

    - Dupuy stated Average casualty daily engagement rates for a Brigade/Regiment (of 3,000 troops) was 2.6%, or alternatively 3.6% (3.58%) (*War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 147-148,

footnote 4 on 356). He gives the numbers of 3% for the attacker and 2.5% for the defender in another work (*Understanding War*, Trevor N. Depuy, Paragon House, 1987, ISBN 0-913729-57-4, pg. 188, 194)

- The current attrition rules create the following outcome (assuming 3.0 combat power). Note that these are not total force casualties as Lawrence's numbers are, but are effect on unit combat power.

Type of Attack	Limited	Failed	Advances	Penetrated
In Game	Attrition Combat	Attacker Attired Result	Exchange Result	Defender Attired Result
Winner	3.3	11.70	11.70	3.3
Loser	0	3.3	11.70	11.70

The differences here are for a few reasons:

1. Brigade combat produces more casualties than the divisional numbers as there are more troops in the "teeth" elements compared to the "tail" elements.
2. This is a 3.0 combat power unit. A unit with more combat power would take proportionally less casualties (as 6.0 unit would take ½ for example).
3. Modern combat is more lethal (I would wager by perhaps .2-.5 so) due to greater battlefield transparency at the tactical level
4. These numbers are not total force casualties. Given information collected above on levels of casualties before units become combat ineffective, we can take a number (say ~50% based on the above data and for ease) before a unit becomes combat ineffective (e.g. reaches 0 combat power). Thus, we would divide the values by 2, as that represents the casualties taken by the teeth force more accurately (roughly).
5. Attrition =/= casualties (in the context of this game). Rather attrition can be considered a combination of KIA, WIA, morale, equipment losses, supply issues, C2 degradation, unit quality degradation, etc.. See the footnote "What is Attrition" above. Thus the rate of attrition of a unit (e.g. ability to fight) is probably higher than it's losses in terms of personnel, as each person is a part of a larger system.

- My views on the determinates of success and degrees of success in attempted breaching obstacles are heavily colored by information from the war in Ukraine (the Kherson and Summer offensives especially), see *Preliminary Lessons from Ukraine's Offensive Operations*, 2022–23, Jack Watling, Oleksandr V. Danylyuk, and Nick Reynolds, 2024, https://static.rusi.org/lessons-learned-ukraine-offensive-2022-23.pdf and *Stormbreak: Fighting Through Russian Defences in Ukraine's 2023 Offensive*, Jack Watling and Nick Reynolds, September 2023, https://static.rusi.org/Stormbreak-Special-Report-web-final_0.pdf, also see *Seven Breaching Habits of Highly Effective Units*, Lt. Col. Thomas H. Magness, https://apps.dtic.mil/sti/pdfs/ADA596549.pdf. This is also why breaching (and failed breaching) is substantially more lethal to units than Depuys 2:1 might suggest.

4. Higher force ratios take more damage from the enemy (contrary to some Dupuy work, for a short overview see https://dupuyinstitute.org/2018/12/14/comparing-force-ratios-to-casualty-exchange-ratios/, for a more through overview see *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 72-78), <u>but not a lot more</u> (e.g. units that are rotated back from the line and given the chance to rest and regroup suffer substantially less ill effects). This is represented in game by having additional unis engaged in the combat take 1 attrition. I disagree with the Depuy Institute's view here because in the modern battle, the ability to bring in fires with more precision and from a longer distance is substantially different from even the 1990's (the data referenced). This is quite similar to Watling's zone of contestation idea (see *The Arms of the Future*, Jack Watling, 2023, ISBN 978-1-3503-5295-7, https://www.bloomsbury.com/uk/arms-of-the-future-9781350352988/, pg. 95-104, or for an earlier view from watling see RUSI Occasional Paper, *The Future of Fires: Maximising the UK's Tactical and Operational Firepower*, Jack Watling,

November 2019, https://static.rusi.org/op_201911_future_of_fires_watling_web_0.pdf, pg. 37-42) That higher force ratios inflict some more damage, but not dramatically more is somewhat consistent with findings from *The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023. For example pg. 94 shows a roughly linear relationship based on force ratio, but with high variability. The general flatness of damage in the game (e.g. basically all results take dice of attrition regardless of the overall force ratio) is in line with *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 72-78.

5. The chance of a breakthrough is very low in most instances (e.g. a forced withdrawal). For a short discussion on this, see the appropriate section in Stephen Biddle's piece here: https://warontherocks.com/2022/11/ukraine-and-the-future-of-offensive-maneuver/ ("Clean breakthroughs followed by exploitation and the decisive conquest of large theaters has long required a permissive opponent — that is, a defender who lacks depth, who has failed to withhold a meaningful reserve, who has failed to ensure cover and concealment at the front, and, often, whose troops lack the motivation to fight hard in the defense of those positions." This can be seen in Ukraine, where despite 6:1 ratios in some parts of the frontline, (*Tactical Developments During the Third Year of the Russo–Ukrainian War*, Jack Watling and Nick Reynolds, February 15th, 2025, https://static.rusi.org/tactical-developments-third-year-russo-ukrainian-war-february-2205.pdf, pg. 5) Russia is unable to mount a breakthrough mostly due to lack of force quality (low troop skill and ability to coordinate large offensive action) and a more transparent tactical battlefield allowing engagement at longer range (pg. 7-8).
6. Levels of attrition in relation to the overall force are *very roughly* in line with the findings of *The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023, pg. 79, the analysis of which I take with a rather large grain of salt mostly due to the data selection (and assumptions) for historical analysis and low(er) number of studies present for some of the factors. Also note that most units nowadays are mechanized infantry and tanks are ubiquitous when looking at Figure 3.12. Functionally, heavier units have higher combat power, and thusly represent the effect of casualties upon the force in proportion to losses taken (e.g. an infantry force takes more casualties, this is represented by the fact that each attrition is proportionally more of it's combat power than with a armored unit).
7. The use of a die to randomize attrition is roughly in line with the levels of randomness seen in Table 12.3 in *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 148. E.g. a unit of over 2,500 people will take on average 12 casualties per day, but with a standard deviation of 20.

Force Ratios

On the topic of force ratios, there is much debate about their utility. I view much of the arguments laid against them to be of less teeth in the context in which they are used here (or in wargaming writ large). This is because 1) there are a multitude of factors (column shifts in this game, plus some other things) that affect the outcome beyond the basic force ratio, and 2) there is randomness injected via dice to cover anything not otherwise covered as well as to represent chance. For further discussion see:

- An Examination of Force Ratios, Maj. Joshua Christian, School of Advanced Military Studies, 2019 https://apps.dtic.mil/sti/pdfs/AD1083211.pdf
    - The main effective criticism of force ratios is that they are historically unvalidated. The problem is there is no other method available other than expert adjudication (which has its own set of problems in accuracy) which would be equally viable. Lacking the ability to have SME's for every game (which I would still be highly wary of anyways), I default to using force ratios as the basis of the CRT.
    - See page 17 for what Depuy did to try to expand beyond force ratios and see their close comparison to what this wargame does. He 1) incorporated outside factors (e.g. column shifts and other effectors in this game), and 2) disclosed the sources and numbers (e.g. the footnotes in this game).

        - Note the conclusion of this piece is very anti-force ratios, but somewhat pro COFM. They key difference being that COFM includes intangibles in it.
        - Perhaps as Depuy says best himself "[historical examples] show why the 3-1 force ratio requirement for the attacker cannot be of *useful value* without some knowledge of the behavior and other combat variable factors involved." (emphasis added). *Numbers, Predictions, and Wars*, Col. T. N. Depuy, Bobbs-Merrill, New York, 1979, ISBN 0-672-52131-8, pg. 11-12
    - Also note pg. 21-26, the discussion of concentration as a key determinate in relation to or opposition to the idea of strategic force ratios as determinate. Given the fact that concentration is becoming more difficult (some RUSI report which I need ot dig up), I think this pushes the argument more in favor of force ratios as an useful explanatory tool, given that forces are more likely to be uniform at higher levels of abstraction like in this game (though not always). Given the way this wargame works (with units as brigade blocks, occasionally lower), it is thus difficult to represent specific concentration at lower than brigade level, except via injection of randomness (dice) and the ability of a commander to achieve concentration successfully. Thus in these rules it is assumed that effective concentration is achieved in line with what the underlying data assumes, but if you can't achieve that you have a column shift against your attack if you the capability to conduct brigade level combined arms attack (of which concentration at the decisive point is a key element). However, at above brigade level it is easy to represent concentration by putting multiple brigades together. Thus I am relatively happy with how this game models it, without having to unduly complicate the rules further.
    - Weakness of depty insitutues TNDM – pg.28
- Dale Spurlin and Matthew Green, "Demystifying the Correlation of Forces Calculator," *Infantry*, (January-March 2017), https://www.moore.army.mil/infantry/magazine/issues/2017/JAN-MAR/pdf/7)Spurlin_CoFCalculator_txt.pdf
    - Again see the section on "The Need for Professional Judgment" to see what else they state are outside factors (which are represented as column shifts for the most part).
- On the 3:1 force ratio, on which the table is centered and which there is much debate:
    - In the CRT for this game in a 3:1 attack (prepared attack vs. prepared defense, the "standard" combat in this game) the attacker is attritted 19% of the time, an exchange occurs 44% of the time, and the defender is attritted 38% of the time.
    - Depuyian Work
        - Note that while I understand the historical numbers Depuy et. al. come up with (e.g. ~2:1 to ~3:1 for a successful attack (generally) with the number being closer to ~2:1, given the various in possible ratios, and the fact that a tactically transparent battlefield favors the defenders, I use 3:1 as the "standard attack ratio."
        - For a short overview of Depuy's work on the 3:1 Ratio see the following: https://dupuyinstitute.org/2016/07/11/trevor-dupuy-and-the-3-1-rule/. Note that 3-1 carries the attack 75% of the time according to Depuy's CHASE data. This is also the case in later looks at Depuy Institute data (74% of the time), see *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 8
        - *Understanding War*, Trevor N. Depuy, Paragon House, 1987, ISBN 0-913729-57-4, pg. 31-37
        - *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 8-13
    - An ancillary validation of the 3:1 rule in Figure 7.5 looking at tactical tank actions *The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023, pg. 183

Why the CRT Ends Where it Does

The table goes up to 11:1+ as I feel beyond a 10:1 force ratio the result is fairly known (going to 11:1 allows for the dice shifts of the randomness in the game better). This maximum of 10:1 is *very* loosely supported by a study on the value of surprise in tank battles, see *The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023, pg. 180-181. The bottom of the table is 1:4 as I feel any attack beyond that is stupid in the extreme, and the relative ratio of forces of any lower can be considered to be as stupid as attacking at 1 to 4 against. Furthermore, the defender's advantage beyond two to one in the defense is limited, and the extra 2 are both there as a stupidity as described previously and to allow to allow for column shifts and dice randomness. This is relatively validated by analysis in *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 10 (Table 2.3), and specifically in the case of 2:1 and lower *Understanding War*, Trevor N. Depuy, Paragon House, 1987, ISBN 0-913729-57-4, pg. 139

[89] ***Flag Results***

Flag here represent not a retreat in the classic wargame sense, but two possible things:

1. Flags in Attacker Damaged in Breaching Attacks: A unit has been damaged and lost cohesion to the point where the unit really should rotate off the line for a bit to regroup and regenerate otherwise it will have undue effects on the unit ().
2. Flags with Defender Attritted: A representation of a unit screening the enemy while withdrawing (fall back in correspondence to the strength of enemy push) or choosing to stand and fight (in which case you trade casualties for holding your position). However, at very high force ratios one will be forced to pull out to avoid being enveloped and destroyed hence (N), while with breaching you can generally safely pull out hence no need for (N) as it represents a rapid need to disengage due to overwhelming speed of enemy movement due to high numbers of forces available to the enemy.

[90] ***Column Shift: Light Infantry vs. Armor***

Light infantry suffers disproportionality when faced with an armored force attacking it. This is true both historically, but also in the modern day. However, modern dismounts are more lethal to armor than previously, and as such I have this column shift apply to armor heavy forces only, as opposed to armor supported forces (e.g. mechanized units). For a discussion on the modern effect see *Heavy Armoured Forces in Future Combined Arms Warfare*, Nick Reynolds, RUSI Occasional Paper, 12 December 2023, https://rusi.org/explore-our-research/publications/occasional-papers/heavy-armoured-forces-future-combined-arms-warfare, pg. 24-27.

[91] ***Column Shift: Air Support***

Strike here is with a squadron of aircraft. Effect is a combination of the strike itself, and aftereffects on morale, unit dispersion, camouflage, and digging in to limit further airstrikes effect thus limiting combat capabilities temporarily. Note that effective air support in an attack could possibly reduce defense effectiveness by as much as 56% (see *The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023, pg. 204), though there are many caveats to this (see caveats on pg. 204, but also the fact that modern CAS is not dive bombing and strafing, so that the reasons for success of CAS on pg. 205 also do apply to modern CAS).

[92] ***Column Shift: Rough Terrain***

Dupuy gives the defensive value of flat terrain as a 1.1 combat power multiplier to the defender, mixed terrain such as the Ardenns and northeastern France is 1.3, and rough terrain as 1.5 (*Understanding War*, Trevor N. Depuy, Paragon House, 1987, ISBN 0-913729-57-4, pg. 96). In this case the light urban, rice paddies, mud flats, and low hills that make up Taiwan to me fall somewhere between mixed and rough (1.3 to 1.5 multiplier) on combat power. On a 3:1 attack this would be 3.9:1 to 4.5:1, or on average 4.2:1, though as with the urban discussion below I think this undersells the benefits, particularly as the tactical battlefield becomes more transparent for urban and especially rice paddies/mud flats/etc. where line of sight is extended by things like drones and movement is either canalized or slow. Thus, I set this as a 5:1, or 2 column shift.

[93] **Column Shift: Urban and Mountain Warfare**

Urban – Force Ratios

Ignoring the debates around the accuracy of force ratios, generally a successful attack is likely at 3:1 attacker to defender. For urban operations, it is difficult to establish a required force ratio for a successful attack. The following table includes force ratios from various sources.

Ratio *AFR = Average Force Ratio* *FR = Force Ratio*	Notes	Source
AFR when attacker success occurred: 5:1 AFR with outliers removed: 2.78:1	23 cases. Excluding outliers of Grozny (Attack Phase), 1st Raqqua, and 1st Grozny (13.7:1, 17.5:1, and 20:1 respectively)	My own database of post-WW2 urban battles with at least one division (-) on one side.
AFR when attacker success occurred: 7:1 (modern only)	9 cases. Likely skewed by GWOT battles.	My own database of post-WW2 urban battles. All were: • Post 1990. • Two forces of equivalent moderate quality, or one force of professional quality. • The battle occurred in urban terrain, in which the intent of one side was to hold urban terrain, and the other to take it. • Divisional (-) sized forces or larger on at least one side.
6:1 required for successful attack	Asserted only, link does not provide a 6:1 number	https://mwi.westpoint.edu/urban-operations-in-ukraine-size-ratios-and-the-principles-of-war/
FR when attacker success occurred: 4-12:1	No attacks occurred at less than 4:1	https://dupuyinstitute.org/2022/08/11/the-defensive-value-of-urban-terrain/
5:1 required for successful attack	US Army Planning Numbers 1940's-50's	*The Chinese Invasion Threat*, Ian Easton, 2017, pg. 39
FR's required for various missions: Delay = .43:1 to .71:1 Prepared Defense = 1:1 to 1.6:1 Hasty Defense = 1.5:1 to 2:1 Hasty Attack = 2.6:1 to 8:1 Prepared Attack = 9:1 to 15:1 Counterattack (Flank): 3:1 to 5:1	US Army Planning Numbers (2022). Some numbers are reformatted so that the ratio can be expressed as 1 (e.g. 3:7 becomes .43:1). Doing some math, on the table we can calculate that (according to the table), the following require X times higher force ratios in urban: Delay = 3-5 times higher Prepared Defense = 3-5 times higher Hasty Defense = 3.75-5 times higher Hasty Attack = 1.04-3.2 times higher Prepared Attack = 3-5 times higher Counterattack (Flank) = 3-5 times higher	ATP 3-06, *Urban Operations*, July 2022, Table 5-1
The effect of urban on combat power could be anywhere from 0% to 20-30%. E.g. 1:1 to 1.3:1	E.g. on the high end an urban attack could require be 4:1, but Lawrence is not able to tell from the data he has.	*War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 228-229

A more concrete dataset is given in *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 244 which provides the following (weighted force ratios have a historically derived combat effectiveness value multiplier to account for some level of intangibles beyond just number of troops, weapons, and equipment):

Ratio for Successful Attack *AFR = Average Force Ratio*	Notes	# of Cases
AFR WW2 Pacific Theater urban attack: 20.09:1, or weighted 3:99:1	Manilla as an outlier is affecting the data. Unweighted urban force ratios are 4.9 x higher than non-urban, but weighted are .93 x higher (1.06 times lower than non-urban)	53 urban, 37 non-urban
AFR WW2 Eastern Theater German urban attack: 2.97:1, or weighted 2.20:1	Unweighted urban force ratios are 1.2 x higher than non-urban, but weighted are 1.34 x higher	28 urban, 31 non-urban
AFR WW2 Eastern Theater Soviet urban attack: 1.26:1, or weighted 2.20:1	Unweighted urban force ratios are .79 x higher than non-urban (1.26 times lower than non-urban), but weighted are .77 x higher (1.3 times lower than non-urban)	23 urban, 15 non-urban
AFR WW2 ETO urban attack: 5.46:1, or weighted 3.24:1	Unweighted urban force ratios are 2.2 x higher than non-urban, but weighted are 1.9 x higher. Note however that this groups German and allied attacks together. Average attacks in nonurban terrain occurred at a 2.46:1 force ratio (1.8:1 weighted). US attacks in nonurban were at much lower force ratios (1.96 unweighted, 1.78 weighted), but overall allied attacks were higher than the average (4:1 unweighted, 2.12:1 weighted).	46 urban, 91 non-urban (of which 17 were allied attacks, and 47 were US attacks only)

Weighting the numbers by the number of cases the average weighted force ratio is 3.04:1 for urban while the average weighted force ratio is 2.27:1 for non-urban terrain (urban is 1.34 times higher in force ratio on average). Discounting the Pacific outliers the unweighted average force ratio is 3.74:1 for urban, and 2.36:1 for nonurban (urban is 1.59 times higher on average). When analogizing however one must be careful as this "1.34 times higher" undersells the difference between urban and open ground, as the comparison here is to nonurban terrain, not open ground to urban, and non-urban includes rough and forest terrain which are more defensible.

So going off this data if 3:1 is required for a successful attack on nonurban terrain, then 4.02:1 would be required for urban terrain (3*1.34 = 4.02). However, 3:1 is likely for open ground (as much as 3:1 can be based on and used to describe anything…), and thusly the real number is likely higher than 4.02:1 as nonurban terrain includes non-open ground and open ground that skew the numbers to be higher than open ground alone.

For a counterpoint to the idea that Urban Terrain is any better on the defense see *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 206-264 (especially 220-221, 235, and the conclusion on 245) also informative on urban warfare (but unrelated to the rest of this) is 265-284, (or for a shorter overview http://www.dupuyinstitute.org/blog/2022/08/11/the-defensive-value-of-urban-terrain/ (2022) noting the complexity (and low number of datapoints). I think the book and these articles (and underlying study) as a whole over relies on historical quantitative data that fails to account for qualitative factors and changes in warfare between World War II and the present day. Note the following issues:

- The type of terrain covered by the dataset (from World War II) would in part not account for megacities (larger streets, grid layouts, large buildings), the increase ubiquity of and proliferation buildings made of modern rebar-concrete (and in Taiwan's case earthquake-proof buildings), and changes in how cities themselves are constructed (for example increased road space allows more direct fire support by vehicles, higher and larger buildings make it easier to retreat into the building,

underground movement options allow for exfiltration), negating some of the applicably (also the data includes co-urban and villages in some cases). Lawrence acknowledges these differences himself (*War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 249).

- Other and similar differences between the data and the modern day are discussed by Lawrence are changes in weapons and tactics, changes to the nature of cities, and changes in technology (*War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 254-255). For a very good overview on the changing future of urban combat see *The Arms of the Future*, Jack Watling, 2023, ISBN 978-1-3503-5295-7, https://www.bloomsbury.com/uk/arms-of-the-future-9781350352988/, pg. 77-92.
- Not discussed but I also view as a difference is that there has been sustainably more training and preparation put into the idea of urban fights, and thus both attackers and defenders will be more prepared, with such a quality improving the defense more than offence as defense is inherently easier. This is also as many attacker advantages (many persistent ISR tools, the ability to use mass fires (without creating rubble), and ability to attack from multiple directions (e.g. low canalization)) don't work or aren't applicable to urban terrain. For some discussion of this see *The Arms of the Future*, Jack Watling, 2023, ISBN 978-1-3503-5295-7, https://www.bloomsbury.com/uk/arms-of-the-future-9781350352988/, pg. 80-83.

In total this leads to me to disagree with the assessment that "Urban terrain does not favor the defender more so than other terrain (rolling or rugged). In fact, it appears less." Functionally I view the value the defender gets at 3 things:

1. The reduction in advance rates indicates a value to the defender.
    a. Perhaps 1/2 to 1/3rd of normal advance ratees, though it is difficult to tell from the given data. See *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 215, 230-232, 241-242, 245)
    b. Also note that penetrations of the defender are less likely in urban terrain (*War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 245)
    c. This is also why in the game system urban terrain allows the defender to ignore retreats:
        i. The density of urban terrain means you are retreating substantially less distance than you would on open ground.
        ii. It provides an end effects model of urban advance rates (it decrease the likelihood of the enemy pushing you out of the urban hex quickly in game terms).
2. The increase in the density of attacking troops indicates a value for urban to the defender. Functionally the attacker must commit more forces to an urban operation than a non-urban operation, meaning they have less forces available elsewhere (e.g. the opportunity cost for an urban operation is larger than for a comparable operation in different terrain).
    a. This is doctrinally supported in ATP 3-06, *Urban Operations,* July 2022, https://armypubs.army.mil/epubs/DR_pubs/DR_a/ARN35826-ATP_3-06-000-WEB-1.pdf, section 4-42 and Table 5-2. A lot of forces can squeeze into a tight space.
    b. Somewhat negated in *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 222 (tepid support), 232-233, 242-243 (negation), 245 (summary). However, I think Lawrence stops short of a full interrogation of the data as the data on pg. 244 does show that on average urban battles weighted force ratio 1.34 times higher than nonurban, and unweighted is 1.59 times higher. I'm also less inclined to agree with a negation argument due to the difference in urban environments between WW2 and today (e.g. it is easier today to put more forces into an given urban area than it used to be, and the value of sheltering forces in urban areas is increased due to the value of cover + concealment offered by buildings in the face of better ISR and precision fires). Lawrence somewhat agrees with this argument (pg. 258)
3. The risk of an increased amount of troop time being spent in urban battles as a result: of #1, or of not fulfilling #2 (e.g. lower force ratios), or also because Urban allows a defender to choose a siege

(rather than surrender as occurs in open ground) as the defender can hold out in Urban terrain rather than risk surrender if they were in comparable circumstance in open ground (I would theorize as the type of terrain limits the amount of force an enemy can apply and the effects of weapons that punish concentration (artillery), while allowing a force to disperse while still remaining in a small geographic footprint (e.g. a force can be dispersed in a smaller geographic footprint in urban, and also be in hardened cover)). This slowness to urban helps provide value to the defender via the same opportunity cost as discussed in #2 (e.g. troop-time committed is higher than compared to operations in other terrain). Functionally this forces a commander to choose to commit more troops to an urban area to clear it at a normal rate, or commit a normal amount of troops to clear it at a slow rate.

   a. Note that *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017 attempts to look at this (pg. 211, 235, 244, 245) but lacks data to draw any conclusions. I suspect that even if they did have the data due to the fact that they are looking at divisional and lower engagements and not the overall battle itself they would not find much evidence one way or another. However, Lawrence agrees with the conclusion made here himself (pg. 251)

Note this above is talking in the context of brigade combat, so the exact value or accuracy of my arguments may vary if one decides to change scope to higher or lower echelons.

It's 5:1 (but make it 6:1)

So taking into account the tables and numbers given (range from no effect, postulated by Lawrence, to up to 15:1 suggested by US Army Doctrine for an attack on a prepared defense), I think the weight of the evidence leans towards 4:1 or 5:1, and given the discussion above on the nature of the historical data that tends towards the lower 4:1, I think 5:1 is more appropriate. Thus, heavy urban terrain is two column shifts (3:1 for a standard attack becomes 5:1 in heavy urban is 5-3 = 2 column shifts). However, I choose to ump this up to 3 column shifts as we need to do some end effects modeling:

Basically, we can consider that while urban terrain does not require more forces inherently, it greatly benefits from more forces. As FM 3-06.11 (2002) states:

> "An attack on urban terrain that is well planned and executed is successful. Such an attack does not have to be casualty or resource intensive. An attacker does not necessarily need a much higher force ratio in urban terrain than in other terrain. The force ratio does, however, have an impact on the duration of combat. Urban combat consumes time that the attacker may ill afford to spend. Urban battles may take two to three times longer than anticipated. Defense in an urban area does not appear to provide a significant advantage to the defender over a defense in other terrain. A well-planned defense in an urban environment can consume the attacker's time (even without combined arms forces or sophisticated weapons), which allows the defender to put other forces to better use or to prepare for other operations. Essentially, the attacker has a favorable situation over the defender during high-intensity combat."

(Combined Arms Operations in Urban Terrain, Field Manual Headquarters No. 3-06.11, Department of the Army, 28 February 2002, section 2-18, https://www.bits.de/NRANEU/others/amd-us-archive/fm3-06.11%2802%29.pdf). This directly draws from work done by the Depuy Institute in 2001 (*War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 206), the same caveats discussed above apply.

The reason for this benefit of more forces is speed. More forces means you advance quicker because more force can be applied, ground held and rear areas protected (this is where the positional aspect of war becomes important due to high density in urban areas), and units rotated for fresh ones when they take damage. Increasing the amount of forces required to be thrown in to achieve success models this process in an indirect manner (e.g. column shifts against the attacker). E.g. urban warfare requires more troops (due to the nature of the space) and more time (due to the nature of the combat) than other terrain. Making it more difficult to fight through and require more forces to overcome an enemy dug in represents that via end effects modeling.

So if the people who say it isn't better defensive terrain, but does take longer to clear and/or requires more troops are right, this game represents that that via end effects modeling (higher defensive value makes it

more time consuming to clear and/or requires more troops to be put towards clearing). Conversely if the people who say it is better defensive terrain are correct, then the game represents it via process modeling (the terrain has a higher defensive value). Either way the game models it correctly, just by different means (though the game is probably slightly more correct if the "better defensive terrain" school is correct).

Urban – Casualties

The attacker generally takes less casualties in urban combat according to historical data, (*The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023, pg. 83-104), though see a direct rebuttal to this point here: https://wavellroom.com/2023/04/28/urban-is-not-exceptional-a-response/. Notably to me there are the following problems with Rowland's training area data:

- It did not include prepared defender obstacles or rubble, or strongpoints (which can provide disproportionate combat power, though with the advent of PGM's less so nowadays)
- They lacked mouseholes for movement (as far as I can tell)
- The buildings were all relatively isolated from one another
- Defenders positions were relatively known.

This likely skewed the data to an unknown degree in favor of the attacker. As Watling's discussion on urban terrain goes, increased uncertainty is a key element of urban battle (negated in trials by knowledge of the defender), as is the canalization of urban terrain (negated in the trials by only having small buildings and a small training area), makes him argue that "the combination of these [urban] factors significantly favors units on the tactical and sub-tactical defense." (*The Arms of the Future*, Jack Watling, 2023, ISBN 978-1-3503-5295-7, https://www.bloomsbury.com/uk/arms-of-the-future-9781350352988/, pg. 80-81).

Lawrence's Historical Analysis agrees with Rowland, see *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 212-213, 229-230, 239-240, 245, 267-271 (casualties), 218-220, 233-235, 243, 245 (armor losses), 249-250 (general). Note in terms of armor losses Lawrence does not (to my knowledge) disaggregate the level of tank losses from the numbers committed to fighting, and the differences might be due to the fact that armor was committed in lower rates in urban areas or in supporting roles as opposed to leading attacks. In the given data this seems to be roughly ½ or 3/4th the casualties that one would otherwise expect to take (pg. 248, 259).

Author Finding	*Source*
General Overview Exchange ratio is approximately .5:1 attacker to defender, but can be pushed as low as .05:1. Counterattacks by the defender can flip this however. (pg. 100) *Attacker Casualties per Defensive MG* Open Terrain = 2.2 (pg. 78) Urban = .61 (pg. 102), 27% of casualties compared to open terrain. Rubbed Urban = .94 (pg. 102), 43% of casualties compared to open terrain.	*The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023
Weighted % Losses Per Day (Excluding Soviet Attacks): Urban: .5% to .71% losses Nonurban: .76% to 1.27% losses In this case urban has 56% to 67% less losses per day.	*War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 259

The likley reason for this is because it is more difficult for units ot mutualy support (watling) leading to a seires of duals where the attacker is more prepared and has more fires avaible to support each dule as the defner has to sprad assets across all possible enemy attacks, while the attacker can conctrate their supporting capaiblites and best troops for the assult force. – note this may not hold at lower/higher levels, and we ar elooking at baslien before absraciton. Theis effect is liley empowered by better tactical ISR and defenter AT fires that exist with drones nowadays, so another shift in favor of defender parity here.

Note that if the attacker or defender is committing more troops to an urban fight the overall force will take more casualties, but if Rowland and Lawrence are correct, they are taking less casualties on a per-unit basis.

Thus, if an attacker is committing more troops to a urban fight, they could take the same or more casualties in compared to another operation, but this is simply due to the number of forces engaged, not that units are taking more casualties in an of themselves. The same is also possibly true of tempo (e.g. it may be that urban fights have a lower tempo than non-urban), but I have no data to establish if this is correct or not. If that urban fights tend to take longer (e.g. have slower rates of advance) as they have a slower tempo, then while they may take less casualties per day, they may take more casualties overall due to the longer comparative time the battle occurs over.

Also note that in discussion of force ratio to casualties, force ratio has less of an effect in the case of urban. (*The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023, pg. 93)

Urban – When Can the Defender Inflict More Casualties than the Attacker?

To assess how and why the defender can inflict more casualties on the attacker than are inflicted on them, I assembled a small database of cases where this happened. Most of the data is pulled from Wikipedia, and coded by my read of the situation, so make of it what you will.

I isolated a number of potential factors (similarities) between the cases, I also look at assessing whether any of the differences stated by Lawrence were important factors (Several I subsumed into one or more of the factors I had picked) see *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 254-258.

Force Ratio Favors the Defender – The force ratio favors the defender. This was true in 1 of 9 cases with 1 unknown. However, to assess whether this was unique, I also compared this all cases. In all cases this was true in 7 in 22 cases.

One Force has a Qualitative Superiority – One force was far qualitatively superior to the other. The defender was qualitative superior in 3 cases and the attacker in 2 cases, with 2 cases where there was no large qualitative difference. 6 cases were unknown.

Highly One-Sided Supporting Fires – One side had a distinct advantage in supporting fires (air, artillery, or both). The defender had advantage in 1 case and the attacker in 3 cases, with 3 cases where there was no large qualitative difference. 5 cases were unknown.

Attacker ROE Restricted at All? – The attacker had a ROE that restrict their ability to engage the enemy with their full force. There was no restrictive ROE in 9 cases, with 1 case unknown. There were no cases of restrictive ROE's in the dataset. While this might be indictive of a possible trend, there are not enough cases to even begin to claim that such a trend exists.

Building Construction – Various building constructs could have an effect on the fighting, but would be difficult to pull out without large numbers of battles. This variable was looked at by what the main type and quality of construction was. There were 4 examples of Soviet-style Concrete, one example of 1940's European City construction (steel frame and/or bricks or masonry), and 3 examples of 2nd World Urban Construction. 4 cases were unknown.

High Amount of Tactical ISR Available (Quadcopters Availability) – the tactical battlefield is transparent due to the ubiquitous presence of ISR quadcopters. This was true in 3 of 11 cases but this is due to the cases, where only 3 battles occurred post 2020. Given that this is likely to be a persistent feature of war, disaggregating it from the rest of the data will be difficult.

Dominant ISR Advantage – given the difficulty of disentangling tactical ISR, a more general look at situations in which the attacker had a dominant ISR advantage over the defender may help show the value of ISR. The defender had advantage in 1 case in 9 cases where there was no large ISR difference. 1 case was unknown, and there were no cases of an attacker advantage in ISR in the cases. To attempt to see if there was a larger value, this was compared to the larger dataset looking at ISR advantage and known victory (ties were treated as defender victory). There were 4 cases where the side with ISR advantage won, and 2 were the side

with ISR advantage lost, there were 42 cases where there was no advantage. Note however that this includes WW2 cases, and if we remove pre-2000's data, we have the same 4 and 2, but this time with 19 cases.

Knowledge of the Local Terrain – knowledge of the local terrain allows for more effective defense and maneuver in the urban space, which is the most complex terrain due to it's 3d nature and density. This was coded Yes if there were units fighting that were local to the area taking a large part in the battle. In 3 of 11 cases the defender had this advantage, and in 1 case they did not 7 cases were unknown.

I'm not going to attempt much further analysis here because there isn't enough data to go off of to make in most cases even initial postulations, and I'm selecting the variables here, so there is a risk of overfitting the variables to the data, as well as the fact that this is a low number of cases and are done with poor data (Wikipedia). Also note I'm not attempting to net out how much of increase in attacker casualties is due to the committing of more forces to the battle. E.g., the attacker or defender is committing more troops to an urban fight so that the overall force will take more casualties, even if they are taking less casualties on a per-unit basis. Basically, take all of this with a massive grain of salt, and I'm not sure that this shows anything too definitive. This is an excellent exercise in showing the value of having dedicated researchers to get you data, and the fact that there are so few urban battles to work off of.

Urban – Taiwanese Advantages

Another method to attempt to calibrate the effect of urban in the rules is to look not only at the general effect already discussed, but at the specifics of urban in a Taiwan contingency to determine if there is deviation from the baseline. All wars and battles are specific to their local factors, and in the case of an invasion of Taiwan there seem to be several situational advantages and disadvantages compared to an "generic" urban battle (if such a thing even exists):

1. *High Civilian Will to Defend Democracy* – As was seen in Kyiv, though thankfully the Molotov's people were making were never put to the test. This could provide combat power, local knowledge, obstacles and other fortification of preparation of the battlefield, and civilian based ISR.
2. *Building Construction* – This has occurred inadvertently by creating earthquake proof buildings which are highly defensible and hardened.
3. *Knowledge of the Local Terrain*
4. *Preparation of Urban Areas* – It is not known, but there may also have been preparation of urban areas for battle in advance. At the very least it seems that evacuation of civilians has been prepared for to some degree.
    a. *Chapter 5: "Killing Rats in a Porcelain Shop": PLA Urban Warfare in a Taiwan Campaign*, Sale Lilly, in *Crossing The Strait, China's Military Prepares for War with Taiwan*, National Defense University Press, 2022, pg. 154.
5. *Underground Infrastructure* – While likely a minor advantage, their will the ability to utilize underground infrastructure such as subway lines, car parks, and underground shopping malls.
    a. *The Chinese Invasion Threat* (2017), Ian Easton, pg. 209. He cites a further article in a Taiwanese military journal, but I cannot find the journal article.
    b. *Chapter 5: "Killing Rats in a Porcelain Shop": PLA Urban Warfare in a Taiwan Campaign*, Sale Lilly, in *Crossing The Strait, China's Military Prepares for War with Taiwan*, National Defense University Press, 2022, pg. 146-147
6. *PLA Urban Warfare Weakness*
    a. Note however this only holds if Taiwanese force quality is superior, and I have not yet come across an assessment of Taiwanese LSCO urban warfare training and preparation.
    b. Sources:
        i. *Chapter 5: "Killing Rats in a Porcelain Shop": PLA Urban Warfare in a Taiwan Campaign*, Sale Lilly, in *Crossing The Strait, China's Military Prepares for War with Taiwan*, National Defense University Press, 2022, pg. 146-147
        ii. *The PLA's Evolving Outlook on Urban Warfare: Learning, Training, and Implications for Taiwan*, Elsa B. Kania and Ian Burns McCaslin, ISW, April 2022, https://www.understandingwar.org/sites/default/files/The%20PLA%20Outlook%20on%20Urban%20Warfare%20ISW%20April%202022_0.pdf

Disadvantages

1. If the Chinese are able to win air superiority (which they may well be able do for some time) then they will have advantages in:
    a. *Highly One-Sided Supporting Fires*
    b. *Dominant ISR Advantage*
2. *ROE restrictions* – I view it as unlikely that the Chinese will have any serious ROE restrictions of any kind for conventional weapons.

There are of course other factors are possible, but they are more situational

Now to compare these we must understand when they the various advantages and disadvantages will be present. The Chinese will likely employ their missile inventory to disrupt, degrade, and destroy US, Taiwanese, and allied airpower at the outset of a conflict. This effect could (depending upon assumptions) could last for up to a month or so (see *Cratering Effects Chinese Missile Threats to US Air Bases in the Indo-Pacific*, Kelly A. Grieco, Hunter Slingbaum, and Jonathan M. Walker, December 2024, https://www.stimson.org/wp-content/uploads/2024/12/Cratering-Effects-Report_Dec-6_WEB.pdf). At some point past the start of the conflict Chinese forces will hit the beachheads and sometime after that (if not thrown back into the sea) advance into urban terrain (assuming the Taiwanese are willing to fight in urban areas of course). Thus, the Chinese have some portion of time where their ability to surveil the urban environment via the air and deliver PGM's by the air will be at it's peak. However, this is a short window in the context of protracted conflict and will be shorter as the Chinese will likely conduct a joint firepower strike for some time before hitting the beach, and they may be delayed getting into urban areas to fight. Furthermore, the latter parts of their window of air supremacy/superiority will begin to become more and more contested (though of course air superiority over Taiwan could last for much longer than the supremacy their missile inventory will buy them for some time). Now, at a certain point in protracted war Taiwanese SAM stocks may begin to deplete and they will be forced to ration, become reliant upon ROCAF, US, or allied air cover, or have the US resupply them with SAMs. This will open some opportunity for air-based effects again.

So all of that said, if we assume a protracted conflict on Taiwan after the landing (which given the terrain, and Taiwanese will to fight, and assuming the US joins the war (both for airpower, and to keep the Taiwanese from surrendering if the US refuses to join), the Taiwanese will have some benefit (but given their type of advantages probably not a massive advantage) in urban warfare when Chinese air delivered effects (PGM's and ISR) are at a minimum, and Chinese advantages maximize when air supremacy/superiority is occurring. Projecting the air environment is incredibly difficult and frankly, I remain conflicted as to what is likely, given that an answer is extremely dependent on assumptions made. Thus, it is best (and also because I believe it is more or less correct) to assume that this is a wash and that on the whole no one side would have a distinct advantage in urban combat to such a degree that it necessitates changing the effect of urban combat in this game.

Mountains

In terms of mountain warfare this is assumed to be the same as heavy urban, as this was a US army planning assumption in the 40's and 50's (*The Chinese Invasion Threat*, Ian Easton, 2017, pg. 39). Also see *The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023, pg. 109-115

[94] ***Column Shift: Fortifications (Theory)***

Fortifications that have been built up extensively can be extremely effective in slowing the enemy and blunting the effects of mass. These are conceptually distinct from more immediately prepared obstacles (e.g. components of a prepared defense in this game, which is a simplification as not all prepared defenses have obstacles and may have them to highly varying degrees), hence the inclusion of "Fortifications" separately. See Russian losses in the battle of Avdiivka (666 vehicles lost compared to 57 Ukrainian, and 16-46,000 Russian casualties) (source https://twitter.com/MassDara/status/1760039863057846536). Fortifications here allow you to ignore flag results as you can fall back onto other pre-prepared defensive lines, negating the

effect of being forced to withdraw from a position and offsetting casualties and personnel losses by fighting from fortified positions.

Depuy states the effect of fortification is a multiply factor of 1.6 (*Understanding War*, Trevor N. Depuy, Paragon House, 1987, ISBN 0-913729-57-4, pg. 95-96), however I view this as lower than it should be. This is because fortifications are in large part comprised of obstacles. Obstacles are only effective when they are observed (otherwise they can be bypassed in relatively short order). As tactical ISR is more and more prevalent and the tactical fight becomes more and more transparent, obstacles (and therefore fortifications) become more and more effective as they are more continually and thoroughly observed by the defender.

[95] ***Column Shift: Fortifications (Effect)***

This is based on the differences in force ratios between European Theater of Operations attacks and Pacific Theater of Operation attacks (e.g. the difference between attacks on fortified Japanese positions and regular combat in the ETO is ~1 in the difference of force ratios), see *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 10-11

[96] ***Column Shift: Fortifications (Special Effects)***

Fortifications increase attacker casualties by 1.65 in historical cases (*The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023, pg. 77). Given increase in lethality and ability to monitor obstacles, I round this up to 2 both to be more accurate and for ease in calculating attrition taken.

[97] Generaly informed by *Maintaining an Armored Division's Momentum through a Wet Gap Crossing*, Center for Army Lessions Learned, 27th of August, 2020,

[98] ***Column Shift: Amphibious Assault***

It is extremely difficult to determine the force ratio difference from 3:1 an amphibious assault requires on average to be successful (*Charting the Pathway to OMFTS: A Historical Assessment of Amphibious Operations From 1941 to the Present*, Carter A. Malkasian, CNA, 2002, pg. 53-59). Given data from the same source (on pgs. 55-56), it seems like past 5:1 the chance of an operational pause lessens dramatically, thus giving us a 2-column shift (3:1 -> 5:1).

[99] So an IADS value of 2, would mean = 20-60% losses, a value of 1 = 10-50% losses, etc. This variability is dependent on how much can be destroyed on landing, as air assaults are very vulnerable in transit, but are extremely vulnerable to artillery attack on the landing zone (see *The Arms of the Future*, Jack Watling, 2023, ISBN 978-1-3503-5295-7, https://www.bloomsbury.com/uk/arms-of-the-future-9781350352988/, pg. 162). I'm not quite sure about the sizing of a d4 vs. d6 vs. d8 vs. d10, as at brigade level such assaults are often battalion sized operations at first, followed by the rest of the brigade later. As such, if the initial battalion is destroyed, then the follow on forces would not arrive to be destroyed as well. If the battalion makes it, then the follow on forces could be destroyed, but are less at risk of doing so, and if both land, then there is minimal destroyed.

The base level of attrition (e.g. a minimum of 10%) is a very first order approximation calculated from attack on Antonov Airport, selected for recency, high competence of Russian forces, and relativity lower quality of Ukrainian air defense and defenders. This gives us the minimum number of casualties on a likely air assault. The defense had Igla's and at least one ZU-23. The initial attack was of ~34 helicopters and 200-300 VDV, and 2 helicopters were lost on the way into the target, with another 3 lost over the airfield, (for numbers used for this see *Anatov Airport,* James Sladden, Liam Collins, Ben Connable, 2024, *The British Army Review*. No. 187, https://chacr.org.uk/wp-content/uploads/2024/03/BAR-187-compressed.pdf, pg. 17-21.), and 1 written off after the attack (https://x.com/MarcinRogowsk14/status/1894474069807960218, I know a twitter/telegram source is suspect, but I feel it credible as it was added to the Oryx list). Counting the 2 shot down before reaching, possibly the one lost immediately after arriving at the airport that is 6%-9% of the force. This is therefore counted as the minimum attrition possible of an attacking air assault force (~10%), higher than the 6%-9% as casualties from landing in exposed positions are not accounted for in the Antonov data (Russian casualties are unknown), and as Stinger performs better than Igla. If facing a functioning IADS, losses would have been higher (e.g. IADS value inclusion), see RUSI work on how the Russians were able to effectively disrupt and discombobulate (resulting in functional suppression) Ukrainian air defense for the opening 24 hours of the war when the assault occurred, and both sites defending the Dnipro (the route to Hostemel) were destroyed (see *Preliminary Lessons from Ukraine's Offensive Operations*, 2022–23, Jack

Watling, Oleksandr V. Danylyuk, and Nick Reynolds, 2024, https://static.rusi.org/lessons-learned-ukraine-offensive-2022-23.pdf, pg. 24-25)

[100] ***Column Shift: Naval Gunfire Support***

[101] ***Column Shift: Brigade Unable to do Brigade Level Combined Arms***

BLUF: This applies to Taiwanese C-Level reserve units, and to PLA units during amphibious attack (PLA amphibious units rarely practice above battalion. *The PLAGF Amphibious Force: Missions, Organization, Capabilities, and Training* , Chapter 4, Dennis J. Blasko, in Study No. 8, Chinese Amphibious Warfare: Prospects for a Cross Strait Invasion, 11/8/2024 https://digital-commons.usnwc.edu/cgi/viewcontent.cgi?article=1000&context=cmsi-studies, pg. 74-75).

Inability to conduct brigade level combined arms has been noted repeatedly for Russian units, but also can be observed in Ukraine's 2023 counteroffensive (see *Preliminary Lessons from Ukraine's Offensive Operations*, 2022–23, Jack Watling, Oleksandr V. Danylyuk, and Nick Reynolds, 2024, https://static.rusi.org/lessons-learned-ukraine-offensive-2022-23.pdf, pg. 31-32, and also in *Stormbreak: Fighting Through Russian Defences in Ukraine's 2023 Offensive*, Jack Watling and Nick Reynolds, September 2023, https://static.rusi.org/Stormbreak-Special-Report-web-final_0.pdf, pg. 21-22). Stormbreak indicates that the two factors are 1) lack of experienced staff, and 2) lack of good junior officers, both of which I view as potentiality being major problems for Taiwanese reserve units (junior officers especially, with the new 150 permanent staff structure for new brigades, staff is likely less problem, but a problem still).

[102] ***Column Shift: Surprise***

This value is drawn mostly from *Deception, Counterdeception and Counterintelligence*, Robert Clark and William Mitchel, 1st Edition, 2019, pg. 6-7 (particularly Figure 1-1 and Figure 1-2). I argue this only applies when attacking as surprise and deception have substantially less effect on the defense (basically allowing for movement of troops/fires to affect correlation of forces, which the effect of such surprise/deception in that case is handled by other things in these rules beyond column shifts).

For an historical analysis/operations research perspective on surprise see *The Stress of Battle: Quantifying Human Performance in Battle for Historical Analysis and Wargaming*, David Rowland, ed. John Curry, 2nd Edition (Hardback), 2023, on Tactical Surprise: pg. 176-184 (pg. 181-183 especially) and 199-203, on Operational Surprise pg. 210-214. Note the qualifier (pg. 176) that operational surprise had a much greater effect than tactical surprise (as studied on the following pages of the book). I however do not draw values for the game from this (beyond the general confirmation of the *Deception, Counterdeception and Counterintelligence* numbers) as reverse engineering the numbers into a usable format is beyond my limited statistical abilities. My thoughts are somewhat informed by *War by Numbers: Understanding Conventional Combat*, Christopher A. Lawrence, Potomac Books, 2017, pg. 121-145 (especially 128-132, 134-135, summary 137 and 140-141). However, I think the analysis and data (WW2, limited data) in the first part of the chapter (pg. 121-131) obscures the importance of actively deceiving the enemy in modern combat (e.g. a more transparent battlefield gives (or perhaps forces) more agency to the deceiver to deceive as the enemy is less likely to have low information on you). Note the second major finding of Lawrence is that Surprise does not increase casualties, which contradicts the *Deception, Counterdeception and Counterintelligence* information. Again note that I do not draw values for the game from this (beyond the general confirmation of the *Deception, Counterdeception and Counterintelligence* numbers) as reverse engineering the numbers is beyond my statistical abilities.

For real world examples see:

- The Ukrainian attack into Kursk (see *How Ukraine Overcame the Transparent Battlefield to Achieve Operational Surprise in Kursk*, Dorsel Boyer and Robert K. Becker, 09/19/2024, https://oe.tradoc.army.mil/2024/09/19/how-ukraine-overcame-the-transparent-battlefield-to-achieve-operational-surprise-in-kursk/) though not noted in the TRADOC piece, but discussed in some open sources was that it appeared higher Russian commanders ignored the tactical commanders on the ground warning of a Ukrainian buildup.
- Then also see the counterfactual in the 2023 Ukrainian Counteroffensive which was well known in advance by the Russians (see *Preliminary Lessons from Ukraine's Offensive Operations*, 2022–23,

Jack Watling, Oleksandr V. Danylyuk, and Nick Reynolds, 2024, https://static.rusi.org/lessons-learned-ukraine-offensive-2022-23.pdf, pg. 30-31).

[103] The nuke here is assumed to be 1MT (not really "tactical", but it is the best data I have as the evidence shows even a big nuke does not do all that well at sinking things). This is based on the example in Gifford - Nuclear Wargaming A Case Study in Educational Wargaming, slides 10, 11, and 12, https://docs.google.com/presentation/d/1TswnFWO06SPa3m3FqfP78U1horRqdGRq/edit#slide=id.p10. Outcomes are: [1-6] a miss (given the large size of naval task forces and the small size of a nuke, this is a distinct possibility, the given example uses a 1MT weapon hit on the center of the task force (the carrier) and still only kills the carrier), [7-10] indicates the nuke hit on target and managed to take out a key element of the force (typically the amphibs or Carrier), there is no catastrophic loss (unit destroyed) as the nuke is too small to kill the entire task force at once. For a short look at what a (23 kt) nuke does to a ship, see *Naval Survivability and Susceptibility Reduction Study - Surface Ship*, Steven Loke Yew Kok, Naval Postgraduate School, Thesis, September 2012, https://apps.dtic.mil/sti/pdfs/ADA567704.pdf, pg. 27-28.

Remember: *Close only counts in horseshoes, hand grenades, and atom bombs.*

[104] This is based on the example in Gifford - Nuclear Wargaming A Case Study in Educational Wargaming, slides 13-16, 20 https://docs.google.com/presentation/d/1TswnFWO06SPa3m3FqfP78U1horRqdGRq/edit#slide=id.p13.

[105] The nuke here is assumed to be 1MT ground or airburst. This section is heavily based upon two pieces of work: *Casualty Estimation for Nuclear and Radiological Weapons*, Carl A. Curling, 2016 https://www.ida.org/-/media/feature/publications/c/ca/casualty-estimation-for-nuclear-and-radiological-weapons/p-5220.ashx (henceforth IDA) and the presentation *Low Yield Nuclear Use in Wargames, It's Not "Game Over Man!"* by James Gifford of the US Defense Threat Reduction Agency at Connections 2022, https://docs.google.com/presentation/d/1U2AYw1POSJTJ_iv_mTw-Pm_nZHIiWeL9/edit#slide=id.p1. In the IDA paper it is assumed that the study's one light infantry battalion represents 30% of the combat power of a brigade, and that the study's dispersion of the battalion is considered to be a defensive posture. Thus a "Dispersed" posture resulting in 30% damage to the Brigade.

[106] Damage against a fresh unit. Damage here is against the overall combat effectiveness of the unit not the whole brigade itself (a minor but important difference), and rear echelon units of the brigade would likely be less affected than combat units.

[107] For an example of why this would be so devastating to a brigade in an urban environment the frontage of a brigade becomes 6-12 blocks, where 1 block is ~100m (see *ATP 3-06 Urban Operations*, July 2022, section 4-42), putting the entire brigade inside the danger zone of a tactical nuclear weapon.

[108] Note that this sheet rounds up when forced to round.

[109] Due to an increasing area of uncertainty due to flight time more missiles must be fired to get the same chance of kill.

[110] This has to do with the nature of the seeker heads employed and clutter in a port (Discussion with RN Lt. Cmdr., May 17th, 2024)

[111] Occasionally one may get lucky and hit a command post, supply dump, or a grouping of enemy troops which could produce a column shift effect. However, in general missile strikes against ground units are relatively ineffective. As stated by Jack Watling on the Ukrainian 2023 counteroffesive: "Collectively, however, these strikes [SCALP/Storm Shadow] never reached the critical level of damage that would disorder the C2 or logistics system. Nor were the strikes themselves effectively synchronised with ground operations that would have caused pressure in tempo with disruption in the deep. This was partly because having effect in the land domain requires the simultaneous servicing of more targets than operations targeting naval forces. The damage to the Black Sea Fleet was absolute. Damaged command posts and bridges, by contrast, could be replaced and repaired." (*Preliminary Lessons from Ukraine's Offensive Operations*, 2022–23, Jack Watling, Oleksandr V. Danylyuk, and Nick Reynolds, 2024, https://static.rusi.org/lessons-learned-ukraine-offensive-2022-23.pdf, pg. 23)

[112] This section is heavily informed by:

- On Attack

    - An author designed single shot kill probability (SSKP) equation model for airfield attack for a separate game.
    - *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, published 2015, Heginbotham et. al., 58-68, 133-160,
    - To some degree *Air Defense Options for Taiwan, An Assessment of Relative Costs and Operational Benefits*, Lostumbo et. al., RAND, 2016, pg. xii-21.
    - *Airbase Vulnerability to Conventional Cruise-Missile and Ballistic-Missile Attacks: Technology, Scenarios, and U.S. Air Force Responses*, John Stillion David T. Orletsky, RAND, 1999, https://www.rand.org/pubs/monograph_reports/MR1028.html, pg. 61-80
    - *Cratering Effects Chinese Missile Threats to US Air Bases in the Indo-Pacific*, Kelly A. Grieco, Hunter Slingbaum, and Jonathan M. Walker, December 2024, https://www.stimson.org/wp-content/uploads/2024/12/Cratering-Effects-Report_Dec-6_WEB.pdf
- On Repair of Airfields
    - *Cratering Effects Chinese Missile Threats to US Air Bases in the Indo-Pacific*, Kelly A. Grieco, Hunter Slingbaum, and Jonathan M. Walker, December 2024, https://www.stimson.org/wp-content/uploads/2024/12/Cratering-Effects-Report_Dec-6_WEB.pdf
    - *Time Estimates to Repair Cratered Runways*, RAND Report, Armas Laupa, February 6, 1970, https://www.rand.org/content/dam/rand/pubs/documents/D19000/D19937/D19937.pdf
        - Note that current methods do not directly recycle the debris as fill as described in this paper, nor is airfield matting or fiberglass matting (to my understanding of unclear wording) usable on runways. See *AFTTP 3-32.10, Introduction to RADR*, 29 November 2024, https://static.e-publishing.af.mil/production/1/af_a4/publication/afttp3-32.10/afttp3-32.10.pdf, pg. 12-15
    - *AFTTP 3-32.10, Introduction to RADR*, 29 November 2024, https://static.e-publishing.af.mil/production/1/af_a4/publication/afttp3-32.10/afttp3-32.10.pdf
    - *Medics and Finance Personnel Repairing Runways? The Air Force Tests It Out*, Chris Gordon, June 1, 2023, https://www.airandspaceforces.com/runway-repair-air-force-multi-capable-airmen/
- Some very limited validation was attempted (though note due to a paucity of information, this is very tenuous at best) by comparing the rules to:
    - The 2017 Shayrat missile strike
    - The October 2024 Iranian strikes against Israel

Note that a strike on an airbase includes attacks on air defense, radars, infrastructure, aircraft, and shelters, and cratering the runway and is assumed to have a mix of unitary and submunition warheads as it optimal.

This makes some assumptions about the availability of runway repair personnel and material (e.g. continual presence of personel, equipment, and fill material). For a discussion on these see *Cratering Effects Chinese Missile Threats to US Air Bases in the Indo-Pacific*, Kelly A. Grieco, Hunter Slingbaum, and Jonathan M. Walker, December 2024, https://www.stimson.org/wp-content/uploads/2024/12/Cratering-Effects-Report_Dec-6_WEB.pdf, pg. 26

[113] Note that while a THAAD battery is not so effective as to be able to shoot down massive waves of ballistic missiles by itself (and cannot to the author's knowledge properly engage cruise missiles), its presence represents a concentration of other air defense including Patriot batteries (or other similar air defense, for the effectiveness of Patriots in a favorable engagement see https://aviationweek.com/defense-space/missile-defense-weapons/saudi-air-defenses-down-six-houthi-ballistic-missiles-48 (2019)) that can engage both cruise and ballistic missiles along with THAAD, decoys, and EW (for EW being able to affect PGM's, see *In a Jam*, Olivia Savage and Sunil JB Babu, Janes Defense Weekly, 5 July 2023), and even the occasional lucky MANPADS (against cruise missiles together helping to degrade incoming missile salvos.

For a short overview on factors going into missile interception see *Air Defense Options for Taiwan, An Assessment of Relative Costs and Operational Benefits*, Lostumbo et. al., RAND, 2016, pg. 12-13.

All this of course assumes that the defending batteries will be able to engage, but given the number of terrestrial sensors in the pacific, the number of space based sensors, and the flight time, it seems reasonable that batteries will be altered and ready to engage an incoming attack. On space based sensors, and especially the Theater Event System, see *AU-18 Space Primer*, 2023, Air Command and Staff College, https://www.airuniversity.af.edu/Portals/10/AUPress/Books/AU-18_Space_Primer_2023.pdf, pg. 107-110.

Aircraft CAP's shooting down cruise missiles is possible and effective at degrading salvos of missiles as seen in Ukraine (provided one has a look down radar), and as above represents the concentration of air defense systems and other efforts such as MILDEC and decoys that degrade the effectiveness of missiles. On decoys for airbase protection there are many types, including some large interesting ones:

- *Tu-95 Decoys Are Being Painted On Russian Air Base's Apron*, Sep 30, 2023 https://www.thedrive.com/the-war-zone/tu-95-decoys-are-being-painted-on-russian-air-bases-apron
- *The Chinese Invasion Threat*, Ian Easton, 2017, pg. 167-168

[114] If missiles are harder to detect, they consequently are engaged by defenses later, and are thus more likely to reach their target and have an effect on the target.

[115] Single salvos can be degraded by air defense at the airbase, and as such have less of a chance of having an effect on the enemy. At 2 or more salvos, the degradation of the missiles by air defense would have minimal effect in relation to the total salvo size that would hit. Note however that interception of supersonic missiles is much more difficult (https://web.archive.org/web/20230310213624/https://twitter.com/MassDara/status/1634300311744438272, which is something the rules do not yet fully account for in this section. Missile speed as subsonic, supersonic, or hypersonic is accounted for in other places in the rules, notably missile salvo size/sea combat, which means that this is partly accounted for but not fully accounted for.

Note a "no effect" result doesn't mean that no missiles got through or hit, but just that their impact was so minimal at the timescale and level of abstraction of the game as to not be worth representing.

[116] Cluster Muntions are devastating against aircraft parked in the open or in unprotected shelters due to their much higher effective radius of damage compared to a standard warhead.
[117] This represents the ability to defeat hardened aircraft shelters and buried infrastructure, as well as to damage runways more effectively.

[118] This represents the ability of larger airbases to disperse aircraft across them, so that aircraft are less at risk given the same number of munitions. For a discussion on this topic, see *Airbase Vulnerability to Conventional Cruise-Missile and Ballistic-Missile Attacks: Technology, Scenarios, and U.S. Air Force Responses*, John Stillion David T. Orletsky, RAND, 1999, https://www.rand.org/pubs/monograph_reports/MR1028.html, pg. 35-38

[119] E.g. if 3 salvos inflict 6 attrition total to a base with 3 parking spaces occupied by 1 squadron (2 unused parking), inflict 4 attrition (6-2 = 4) to the aircraft at the base.
[120] This section pulls from the airbase table, but reflavors it to my understanding of ports. Once again see *The U.S.-China Military Scorecard Forces, Geography, and the Evolving Balance of Power, 1996–2017*, RAND, published 2015, Heginbotham et. al., 58-68, 133-160.

[121] Note that these rules assume that the correct type of mines for the given target and geographical conditions are being used.

[122] Cancian, Matthew (2022) "*An Offensive Minelaying Campaign Against China*," Naval War College Review: Vol. 75: No. 1, Article 6. https://digital-commons.usnwc.edu/nwc-review/vol75/iss1/6, pg. 2, states a clearance rate of .8-2 mines per day. 1.5 is used as a close middle that is easy for people to do mental arithmetic with. Lower clearance rates are more likely due to the higher degree of technical sophistication of US mines compared to historical examples (pg. 12).

[123] Cancian, Matthew (2022) "An Offensive Minelaying Campaign Against China," Naval War College Review: Vol. 75: No. 1, Article 6. https://digital-commons.usnwc.edu/nwc-review/vol75/iss1/6, pg. 12 looking at Wonson Harbor gives a 2/15 = 13.3% chance. *Chapter 8 Mine Warfare*, A. Washburn, M. Kress, Combat Modeling, International Series in Operations 161 Research & Management Science 134, DOI

10.1007/978-1-4419-0790-5_8, pg. 170 however states that Wonson was an anomaly and the actual rate of loss is much lower. Thus, I go with 1% per day.

[124] Cancian, Matthew (2022) "*An Offensive Minelaying Campaign Against China*," Naval War College Review: Vol. 75: No. 1, Article 6. https://digital-commons.usnwc.edu/nwc-review/vol75/iss1/6, pg. 13. While this is an imperfect model in many respects, this means that smaller minefields are easier to clear lanes through and thus is a usable approximation without having to deal with more complicated models (for more on such models see *Chapter 8 Mine Warfare*, A. Washburn, M. Kress, Combat Modeling, International Series in Operations 161 Research & Management Science 134, DOI 10.1007/978-1-4419-0790-5_8, pg. 162-163). While the model has a simplistic method of mining it does benefit from modeling minesweeper casualties (pg. 170-171), but does not model uncertainty over the minefield or multiple mine and sweeping types (pg. 172-173).

[125] The number here (10%) is picked arbitrary to match the number required to clear a lane. For more on this, see *Mine Warfare in a Cross-Strait Invasion*, Chapter 11, Thomas Shugart, in Study No. 8, Chinese Amphibious Warfare: Prospects for a Cross Strait Invasion, 11/8/2024 https://digital-commons.usnwc.edu/cgi/viewcontent.cgi?article=1000&context=cmsi-studies, pg. 221

[126] Ukrainain SOF have proved effective in this role (*Ukraine Special Operations Forces and the Lessons Learned for Large-Scale Combat Operations*, Doug Livermore, 1/31/2025, https://smallwarsjournal.com/2025/01/31/ukraine-special-operations-forces/). Ukrainian SOF can "reconnoitre 30 miles of coastline over a two-week period". This works out to about ~2 miles a day. (*Ukraine's western-trained 'navy seals' unleash wave of destruction*, Maxim Tucker, September 10 2024, https://www.thetimes.com/world/russia-ukraine-war/article/ukraines-western-trained-navy-seals-unleash-wave-of-destruction-q6n96llhw) Given that most sorts of these recce mission operate from a camouflaged observation post and want low emissions (no drones, aggressive patrolling) then the ability to detect only one unit (or airbase) at a time.

[127] The first part of this section is a compilation of historical data, then followed by analysis and derivation of the number. It draws mostly from *Snakes in the Eagle's Nest: A History of Ground Attacks on Air Bases*, Alan J. Vick, RAND Report, 1995, https://www.rand.org/pubs/monograph_reports/MR553.html. This section will mostly look at penetrating attacks, defined as:

> "Penetrating attacks typically are done covertly by small teams who slip through the defensive perimeter and place bombs with time fuses (satchel charges) on aircraft and materiel." (pg. xv)

Penetrating Attacks against Airbases to Destroy Aircraft by Platoon or Smaller Elements (WW2)

Attack	Place, Year	Effect	Source
WW2 #9		Equipment Destroyed	*Snakes in the Eagle's Nest*
WW2 #10		1 destroyed	*Snakes in the Eagle's Nest*
WW2 #11		3 destroyed	*Snakes in the Eagle's Nest*
WW2 #12		1 destroyed	*Snakes in the Eagle's Nest*
WW2 #17		–	*Snakes in the Eagle's Nest*
WW2 #18		–	*Snakes in the Eagle's Nest*
WW2 #19		–	*Snakes in the Eagle's Nest*
WW2 #20		–	*Snakes in the Eagle's Nest*
WW2 #25		Trucks on road destroyed instead	*Snakes in the Eagle's Nest*
WW2 #26		–	*Snakes in the Eagle's Nest*
WW2 #27		24 destroyed	*Snakes in the Eagle's Nest*
WW2 #29		37 destroyed	*Snakes in the Eagle's Nest*
WW2 #31		–	*Snakes in the Eagle's Nest*
WW2 #32		27-30 destroyed + fuel dump destroyed + ground crews killed.	*Snakes in the Eagle's Nest*
WW2 #33		–	*Snakes in the Eagle's Nest*
WW2 #34		2 destroyed	*Snakes in the Eagle's Nest*
WW2 #36		–	*Snakes in the Eagle's Nest*
WW2 #37		–	*Snakes in the Eagle's Nest*
WW2 #38		15 destroyed	*Snakes in the Eagle's Nest*
WW2 #39		1 destroyed + trucks	*Snakes in the Eagle's Nest*
WW2 #40		–	*Snakes in the Eagle's Nest*
WW2 #41		5 destroyed	*Snakes in the Eagle's Nest*
WW2 #43		8 destroyed	*Snakes in the Eagle's Nest*
WW2 #44		–	*Snakes in the Eagle's Nest*

WW2 #45		–	*Snakes in the Eagle's Nest*
WW2 #46		21 destroyed	*Snakes in the Eagle's Nest*
WW2 #47		20 destroyed	*Snakes in the Eagle's Nest*
WW2 #48		11 destroyed	*Snakes in the Eagle's Nest*
WW2 #49		1 destroyed	*Snakes in the Eagle's Nest*
WW2 #50		–	*Snakes in the Eagle's Nest*
WW2 #51		Fuel dump	*Snakes in the Eagle's Nest*
WW2 #52		37 destroyed	*Snakes in the Eagle's Nest*
WW2 #53		15 destroyed	*Snakes in the Eagle's Nest*
WW2 #54		–	*Snakes in the Eagle's Nest*
WW2 #55		–	*Snakes in the Eagle's Nest*
WW2 #56		22 destroyed	*Snakes in the Eagle's Nest*
WW2 #57			*Snakes in the Eagle's Nest*
WW2 #58		–	*Snakes in the Eagle's Nest*
WW2 #59		–	*Snakes in the Eagle's Nest*
WW2 #60		–	*Snakes in the Eagle's Nest*
WW2 #61		40 destroyed	*Snakes in the Eagle's Nest*
WW2 #62		15 destroyed	*Snakes in the Eagle's Nest*
WW2 #63		–	*Snakes in the Eagle's Nest*
WW2 #65		10 destroyed	*Snakes in the Eagle's Nest*
WW2 #66		10 destroyed + fuel dump	*Snakes in the Eagle's Nest*
WW2 #67		32 destroyed/damaged	*Snakes in the Eagle's Nest*
WW2 #68		Unknown effect (effective, but quantity unknown)	*Snakes in the Eagle's Nest*
WW2 #78		–	*Snakes in the Eagle's Nest*
WW2 #79		–	*Snakes in the Eagle's Nest*
WW2 #80		–	*Snakes in the Eagle's Nest*
WW2 #81		5 destroyed	*Snakes in the Eagle's Nest*
WW2 #82		–	*Snakes in the Eagle's Nest*
WW2 #83		Fuel Dump	*Snakes in the Eagle's Nest*
WW2 #84		~5 destroyed	*Snakes in the Eagle's Nest*
WW2 #87		Unknown effect	*Snakes in the Eagle's Nest*

Penetrating Attacks against Airbases to Destroy Aircraft by Platoon or Smaller Elements (Korean War)

Attack	Place, Year	Effect	Source
Korea #1	Pohang, 1950	–	*Snakes in the Eagle's Nest*
Korea #3	Multiple Locations, 1950	–	*Snakes in the Eagle's Nest*

Penetrating Attacks against Airbases to Destroy Aircraft by Platoon or Smaller Elements (1960 to Today)

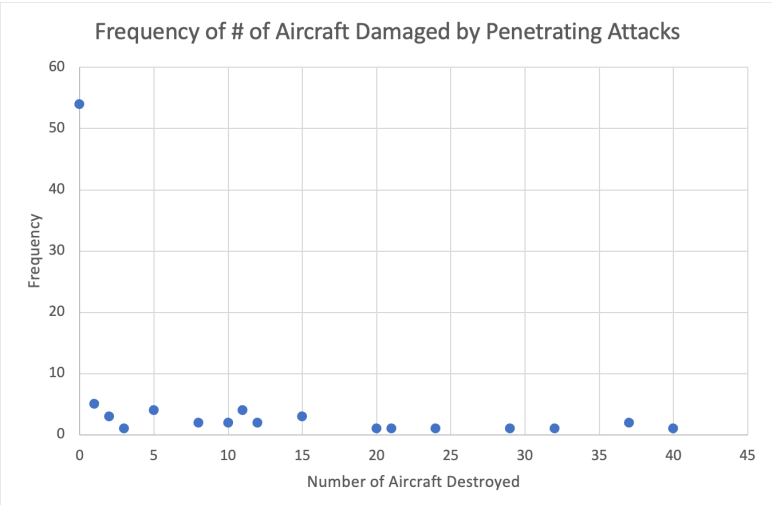
Attack	Place, Year	Effect	Source
Vietnam #16	Vietnam, 1966	20 damaged	*Snakes in the Eagle's Nest*
Vietnam #32	Vietnam, 1967	–	*Snakes in the Eagle's Nest*
Vietnam #53	Vietnam, 1968	–	*Snakes in the Eagle's Nest*
Vietnam #131	Vietnam, 1968	1 Hvy, 1 Moderate, 1 Lgt. Damage	*Snakes in the Eagle's Nest*
Vietnam #133	Vietnam, 1968	2 destroyed, 7 damaged	*Snakes in the Eagle's Nest*
Vietnam #166	Vietnam, 1968	–	*Snakes in the Eagle's Nest*
Vietnam #168	Vietnam, 1969	–	*Snakes in the Eagle's Nest*
Vietnam #192	Vietnam, 1969	–	*Snakes in the Eagle's Nest*
Vietnam #240	Vietnam, 1969	2 damaged	*Snakes in the Eagle's Nest*
Vietnam #276	Vietnam, 1970	–	*Snakes in the Eagle's Nest*
Vietnam #284	Vietnam, 1970	–	*Snakes in the Eagle's Nest*
Vietnam #297	Vietnam, 1970	–	*Snakes in the Eagle's Nest*
Vietnam #338	Vietnam, 1970	1 damaged	*Snakes in the Eagle's Nest*
Vietnam #386	Vietnam, 1971	–	*Snakes in the Eagle's Nest*
Vietnam #410	Vietnam, 1971	–	*Snakes in the Eagle's Nest*
Vietnam #422	Vietnam, 1971	–	*Snakes in the Eagle's Nest*
Vietnam #434	Vietnam, 1972	3 damaged	*Snakes in the Eagle's Nest*
Vietnam #435	Vietnam, 1972	Munitions destroyed	*Snakes in the Eagle's Nest*
Vietnam #456	Vietnam, 1972	–	*Snakes in the Eagle's Nest*
Muñiz Air National Guard Base	Puerto Rico, 1981	9 destroyed	156th Wing Information Page
Raid on Pebble Island	Falklands, 1982	11 destroyed/damaged	*Snakes in the Eagle's Nest,* OMCT #8

Battle of Ilopango Airport	El Salvador, 1982	11-28 destroyed	*https://time.com/archive/6699019/el-salvador-bombs-and-broadsides/*
Battle of Paitilla Airport	Panama, 1989	1 destroyed	Wikipedia
OMCT #14	El Salvador, 1990	1 damaged	*Snakes in the Eagle's Nest*
OMCT #17	Puerto Rico, 1991	1 damaged	*Snakes in the Eagle's Nest*
OMCT #18	Iraq, 1991	7 damaged	*Snakes in the Eagle's Nest*
Bandaranaike Airport attack	Sri Lanka, 2001	12 destroyed, 14 damaged	Wikipedia
Raid on Anuradhapura Air Force Base	Sri Lanka, 2007	8-15 Aircraft	Wikipedia
PNS Mehran attack	Pakistan, 2011	2 destroyed	Wikipedia
Raid on Camp Bastion	Afghanistan 2012	8 destroyed	Wikipedia
Camp Simba attack	Kenya, 2020	5 destroyed, 1 damaged	Wikipedia
Mianwali air base attack	Pakisan, 2023	3 damaged	Wikipedia

OMCT = Other Modern Conflicts and Terrorism

When using this data, I only selected entries I knew were direct action attacks by a small force (platoon or smaller) post 1960. Some datapoints were not marked clearly (*Snakes in the Eagles Nest* Vietnam #20, #30, #432, Other Modern Conflicts and Terrorism #3, #10,) or were not able to be disaggregated (*Snakes in the Eagles Nest* #165, #353, #397, #419). Other attacks that were not used as their intent to attack aircraft was uncertain or unlikely. Suspected biases in the data is that post 1995 data (data not from the *Snakes in the Eagle's Nest*) is biased towards successful attack, as there is little reporting of unsuccessful attacks. Such data is also biased by being attacks from terrorists or irregular forces.

From this data 34 of 88 attacks (38.6%) resulted in destruction of aircraft (damaged airframes, base infrastructure, equipment, or killed personal were not counted). There is no visible correlation or grouping of the number of airframes destroyed in attacks, other than numbers between 1-15 seem to be slightly more common than those in the 20-40 range.



However, if we look at attacks that managed to penetrate and destroy or damage aircraft or other things (infrastructure, equipment, or killed personal), the success rate of attacks is 50 in 88 or 56.8%. In 23 cases damage was also caused to aircraft or other things, in 16 of these cases no aircraft were destroyed, only other damage was caused.

However this isn't the full story. Chances of a successful attack may vary by time period. Looking at attack we know of WW2 (including Korea) attacks were effective in causing damage 33% of the time, in Vietnam 37%, and post-Vietnam 100% of the time. The post-Vietnam effect is due to sampling bias of a lack of inclusion.

The following factors need to be considered before arriving at a final discussion as historical data is not sufficient in and of itself, it must be taken in the context of difference between what has happened historically and how it is being applies. In this case factors decreasing effectiveness would be:

- Tyranny of distance in the pacific theater makes infiltration/exfiltration more time consuming and risky.

- More pervasive sensors and more hostile territory than in the given data
- Base defenses are likely to be better than weak Italian/German and variable quality US base defenses in Vietnam and Thailand.

Factors increasing effectiveness:

- SF are better trained than forces in the historical data.
- Better night operational capability.
- Better indirect fire weapons and equipment.

Thus, I conclude that the factors moderately favor the defender, and thus the chance of a successful attack is 30%.

The possible outcomes are (very roughly) from a penetrating attack:

Outcome	No Effect	1-15 Aircraft Destroyed (1 squadron in game terms)	20+ Aircraft Destroyed (2 squadrons in game terms)
Chance of Occurrence	~60%	30%	10%

The risk of these should probably be rounded up however as these attacks don't include the use of indirect fire, which is more damaging (e.g. it is assumed that the SF will attempt to penetrate the perimeter and attack, but may well carry indirect fire weapons to support the penetrating or assault element). The exact value of indirect fire here varies heavily on how crowed the base is however:

> "At Tan Son Nhut – reportedly the most crowded of the bases – 1 aircraft was damaged for every 3 rounds fired. At Da Nang and Bien Hoa, both known for their severely crowded ramps, it took 4 and 6 rounds, respectively, to damage 1 aircraft. In contrast, on average it took 20 rounds to damage 1 aircraft at Phan Rang. Relatively few aircraft were destroyed per round; for example, only 1 aircraft was destroyed at Da Nang for every 50 rounds fired." (*Snakes in the Eagles Nest*, pg. 94)

The exact value of indirect fire here is difficult to tell. The following table includes Sapper attacks against US bases during the Vietnam War, but is overwhelmingly dominated by indirect fire. The average here is ~28.5% of attacks being successful, very similar to the 30% number selected above.

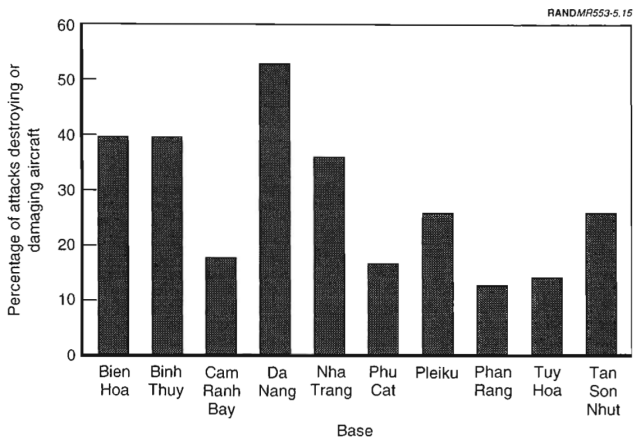


Figure 5.15—Attack Success Rate, by Base

Snakes in the Eagles Nest, pg. 96

The above is too general however, let us look at attrition in game terms and use that to guide the effects. Attrition in aircraft squadrons in the game is in units of 6 aircraft.

Group	No Effect	Damage, No Aircraft Destroyed	1-6 Destroyed	7-12 Destroyed	13-18 Destroyed	19-24 Destroyed	25-30 Destroyed	31-36 Destroyed	37-42 Destroyed
# of Instances	36	7/9*	13	10	4	5	1	0	3

* 7 instances of damage to airfield facilities with no damage to planes, and 9 instances of damage but no destruction of planes.

If we group the higher levels together where a squadron would be wiped out 13-24, and discount the outliers of the very high end (larger MG truck attacks that would be difficult to carry out), and drop Damage, No Aircraft Destroyed (in most cases was damage to one or two planes) the then we have the following table:

Group	No Effect	1-6 Destroyed	7-12 Destroyed	13-24 Destroyed
Game Effect	No attrition	1 attrition	2 attrition	3 attrition
# of Instances	36	13	10	9
% Chance	53%	19%	15%	13%

This can be easily mapped to a 1d6-3 roll (each roll being a 16.6% chance). This probably underrepresents the chance of a 1-6 destroyed, as attrition covers damage that incapacities 6 aircraft of fighting power, but given these are covering ranges (e.g. 1 attrition would be likely 3-9 aircraft destroyed), including damage helps with this (e.g. covers for events when 1 or two aircraft are destroyed, but multiple other ones are damaged resulting in a mission kill of 6 aircraft).

[128] *Ukraine's Special Operations Troops Sow Destruction in Russia*, Doug Livermore, August 23, 2024, https://cepa.org/article/ukraines-special-operations-troops-sow-destruction-in-russia/, AND *Against the Odds: Lessons from the Ukrainian Resistance Movement,* Oleksandr V Danylyuk*,* 4 July 2023, https://www.rusi.org/explore-our-research/publications/commentary/against-odds-lessons-ukrainian-resistance-movement

[129] This represents the use of SOF to support brigades. While this may overlap with other missions (e.g. missions and/or targets may be the same even if not directed to support a brigade), this is the specific tasking and use of SOF in support of a brigade as opposed to tasking for other things and is often shorter duration in nature (see *SOF-CF Interoperability in Large-Scale Combat Operations: Insights From the Warfighter Exercises, MAJ David M. Spangenberg*, July 2021, https://api.army.mil/e2/c/downloads/2021/08/23/1b322a74/21-652.pdf, pg. 1). Note that this includes not just the physical output of the attacks but the psychological effect leading to degradation of combat power too. An example of this can be seen during the Kursk offensive operation in 2024 (*Ukraine's Special Operations Troops Sow Destruction in Russia*, Doug Livermore, August 23, 2024, https://cepa.org/article/ukraines-special-operations-troops-sow-destruction-in-russia/). Note that I have this brigade support apply in both attritional fights (where the SOF are likely providing specialized ISR support for fires, elite raiding troops to capture specific positions or enemy personal, or (less optimally) as elite assault troops or high quality infantry in critical areas of the defense or mobile reserve roles), or maneuver fights where they are providing more diverse effects more deeply into the enemy rear. While these call on different SOF mission sets, they are missions sets that SOF can provide in both instances (though the attritional missions are likely easier to plan for as they require less complex and time intensive planning and shaping) as seen in Ukraine and thusly the column shift is not limited to one either attritional or mauver only.

See also *Ukraine Special Operations Forces and the Lessons Learned for Large-Scale Combat Operations*, Doug Livermore, 1/31/2025, https://smallwarsjournal.com/2025/01/31/ukraine-special-operations-forces/.