
OVERVIEW OF THE JICM

The JICM (Joint Integrated Contingency Model) is a game-structured simulation of major regional contingencies, covering strategic mobility, conventional warfare in multiple theaters, and naval warfare. It is a deterministic model with a four-hour time step.

The JICM air war is organized around an ATO (Air Tasking Order), which explicitly packages sorties at the start of each day to execute across the six four-hour periods. The JICM models a number of different air-to-air and air-to-ground missions, including:

- DCA Defensive Counterair, defense against penetrators
- Sweep Fighters that precede penetrators to engage DCA
- SEAD Suppression of Enemy Air Defenses, attacking SAMs
- OCA Offensive Counterair, attacking air bases
- AI Air Interdiction, attacking fixed targets.

Some of the factors accounted for in the model are:

- Sortie rates by aircraft type and basing distance, including surge capability
- Air-to-air missile types and numbers carried
- Precision-guided munition numbers and capabilities
- Aircraft capabilities and stealth differences
- Pilot quality

- Differing mission packages
- Geographic and mission effects on engagement rate
- Engagements per sortie (and the advantages of fire-and-forget missiles)
- First-shot advantages for more modern aircraft
- Suppressed or aborted DCA and strike sorties beyond attrition
- Ballistic missile attacks on SAMs and air bases
- Effect of IADS damage on SAMs
- Effect of air base damage on sortie generation
- Aircraft killed in shelters
- Air base repair.

Air war adjudication is done in the following steps:

- Sweep packages attacking DCA
- SEAD packages attacking SAMs
- SAMs attacking sweep and strike packages
- DCA packages attacking strike package escort
- DCA packages attacking strike package mission sorties.

Because the JICM is a deterministic model, engagements are not resolved by randomly pairing packages but by fighting each attacking package against each defending package. Probabilistic factors that would normally select some packages but not others (such as the percentage of packages engaging) are instead applied as fractions to each package.

The same general process applies to each of the adjudication steps above. First, engagement rates determine the number of sorties from each package that engages. Second, each attacking package is allocated across all defending packages such that defending packages each face a composite attacker made up of slices of each attacking package. Third, each defending package is adjudicated against its composite attacker. The engagement vulnerability score of each package determines the fraction of each side that shoots before getting

shot at. Attrition is then totaled and allocated back to the participating packages.

AIR-TO-AIR ADJUDICATION

Engagement Rates

Engagement rates limit the number of sorties that engage in each adjudication step and are calculated for each package. Because the JICM is a deterministic model, engagement rates are applied separately to each package. For example, an engagement rate of 75 percent means that 75 percent of the sorties in a package engage rather than 75 percent of the packages.

The engagement rate for attacking packages is based on factors that represent how well the attacker can predict and cover the areas where the defender will be and how well the attacker can react when he is less than perfect in the first factor.

The Taiwan theater is small and as a relatively few air bases are the focus of the strikes, the coverage factor for sweep attacking DCA is a fixed 100 percent. Sweep does not have a reaction adjustment because it must largely predict where DCA will appear.

For DCA attacking strike packages, the coverage factor is based on the physical space the total DCA sorties can cover compared with the size of the theater. Again, because of the small size of the theater, this factor was always 100 percent. The reaction adjustment for DCA is represented by raising the coverage fraction to the exponent 0.5.

Engagement rates for defending packages are based on the coverage of the attacking packages and the vulnerability of the defending aircraft to engagement. Vulnerability is a data item for each aircraft type that represents the ability of the aircraft to avoid engagement through a combination of stealth, avionics, performance, and weapon range. Typical values are from 0.5 for modern aircraft to 1.0 for prior-generation aircraft.

For sweep attacking DCA:

$$\text{base-sweep-engagement-rate} = \text{sweep-coverage-parameter}$$

$$\text{base - DCA - engagement - rate} = \text{sweep - coverage - parameter} \bullet \text{package - vulnerability}$$

For DCA attacking strike packages:

$$\text{base - DCA - engagement - rate} = \text{DCA - theater - coverage} ^{0.5}$$

$$\text{base - striker - engagement - rate} = \text{DCA - theater - coverage} \bullet \text{package - vulnerability}$$

Note that the engagement rates of all attacking packages will be the same, while those of the defending packages will vary according to their individual vulnerabilities.

An additional engagement constraint is based on the ratio of total engaged sorties. Because DCA is trying to avoid sweep and sweep must spread out to cover DCA operating areas, we limited the ratio of total engaged sweep and DCA sorties to 1:1, meaning that each sweep sortie engaged at most one DCA sortie. We limited the ratios of DCA versus escort and strike sorties to 2:1, meaning that up to two DCA sorties could engage each escort or strike sortie.

$$\text{sortie - ratio} = \frac{\text{total - friendly - engaged - sorties}}{\text{total - enemy - engaged - sorties}}$$

For each package:

$$\text{engagement - rate} = \text{base - engagement - rate} \bullet \text{minimum}(\text{sortie - ratio}, \text{allowed - ratio})$$

Attacker Allocation Across Defenders

The attacker allocation process allocates a fraction of each attacking package to each defending package. For air-to-air engagements, the allocation is in proportion to the number of engaged sorties in the defending package compared with the total for the side.¹

¹For engagements involving disparate types of forces, such as SAMs engaging aircraft, missiles, and standoff weapons, the effectiveness of the attacker against the different

For each attacking package versus each defending package:

$$\text{fraction - allocated} = \text{defender - sorties} \bullet \frac{\text{package - engagement - rate}}{\text{total - engaged - sorties}}$$

For example, consider an engagement with two sweep packages of four sorties, each with an engagement rate of 50 percent, versus two DCA packages of four sorties with engagement rates of 100 percent and 50 percent. Two sorties in each sweep package are engaged, versus four sorties in the first DCA package and two sorties in the other. Therefore, four-sixths of each sweep package is allocated against the first DCA package, and two-sixths against the second.

Adjudicating Air-to-Air Engagements

Following the allocation of attackers to defenders, each defending package is adjudicated in turn against the collection of fractional packages allocated against it.

The adjudication process depends on the number and score of weapons carried and the air-to-air vulnerability of each sortie. The defending package (DCA, striker escort, or striker mission sorties) is always a uniform type of aircraft, and so their true weapons and vulnerability are used. The weapons used by the attacker are the total across all allocated sorties but with an averaged score. The vulnerability of the attacker sorties is taken to be the best vulnerability of any of the allocated sorties.

In our cases, PRC sweep, striker escort, and striker mission sorties were of uniform vulnerability, but ROC DCA sorties were not. The ROC IDF aircraft has a worse vulnerability than other ROC aircraft (0.8 compared with 0.5). This results in a bias in favor of the ROCAF when ROC DCA is attacking strike packages, because all sorties use the best (0.5) vulnerability. Because the PRC striker packages are previous-generation aircraft, this engagement is one-sided anyway.

For each defending package:

defenders and the ability of the attacker to discriminate between defenders is also considered.

attacker-shots = total from allocated attacking sorties
attacker-score = average from attacker weapons
attacker-vulnerability = best from allocated attacking sorties
defender-shots = total from defender sorties
defender-score = score from defender weapons
defender-vulnerability = vulnerability from defender sorties.

Shots Taken

Because of the short sortie distances in this theater and the training limitations of the two sides, we limited each sortie carrying semiactive guidance missiles to only one engagement. To accomplish this, we loaded these aircraft with only two missiles, which would both be fired at the first target engaged. BVR fire-and-forget weapons, such as the AIM-120 or AA-12, were not subject to this constraint, and sorties were allowed their normal complement of these weapons in addition to two semiactive guidance missiles. Such aircraft as the U.S. F-15C, which carried four AIM-120s and two AIM-9, could shoot at up to three targets with two missiles each.

maximum-shots-per-shooter = 2 + fire-and-forget-weapons.

The number of shots taken at each target was also limited to four, but reduced by the target sortie's air-to-air vulnerability.

maximum-shots-per-target = 4 • air-to-air-vulnerability.

Therefore, modern aircraft with 0.5 vulnerability could have at most two shots taken against them, while previous-generation aircraft could have up to four.

This constraint was only limiting in the sweep versus DCA engagement when sorties with fire-and-forget missiles engaged modern, 0.5-vulnerability aircraft. In these cases, the shots by the ROC DCA that could not be expended against the PRC sweep were later used against the 1.0-vulnerability escorts and strikers. Because the ROC DCA also includes 0.8-vulnerability IDF aircraft, PRC sorties with AA-12s are generally not shot-limited.

Weapon scores represent an expected number of kills (EK). The score for each shot is an average of all weapons on the sortie.

First Shot

In addition to limiting the number of engaged sorties, air-to-air vulnerability also determines the fraction of each side that is given the first shot. The adjudication of each defending package against its allocated attackers begins with determining the fraction of first shots that goes to the side with the lowest vulnerability.

$$\text{first-shot-fraction} = 0.5 + 0.5 \cdot (\text{high-vuln} - \text{low-vuln}) ^ 0.2.$$

Figure B.1 shows the relationship between the difference in vulnerability and the percentage of first shot that goes to the side with the

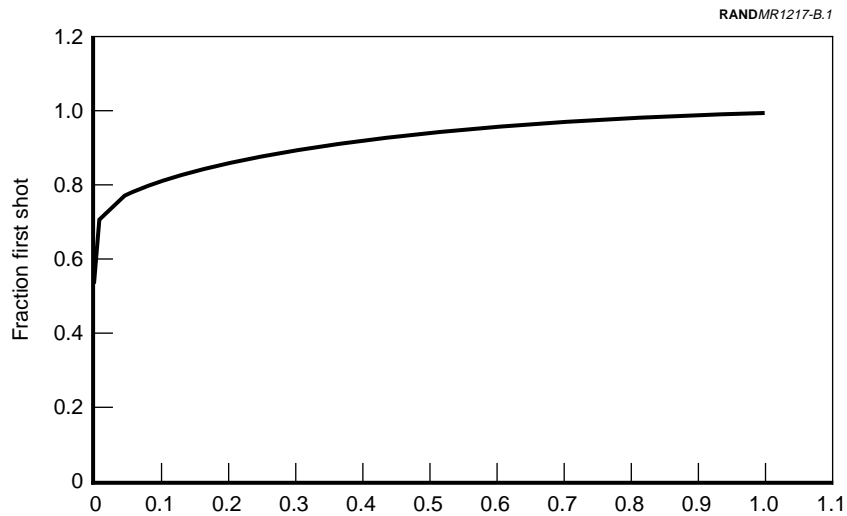


Figure B.1—Fraction of Package with First Shot

lower vulnerability. Note that at equal vulnerability (a difference of zero) 50 percent of each side shoots first.

This fraction is implemented by dividing the adjudication into two subadjudications according to the first-shot fraction. For example, a vulnerability difference of 0.1 gives a first-shot fraction of 0.82. In the

first adjudication, 82 percent of the side with the lowest vulnerability shoots first at 82 percent of the other side, and the survivors shoot back. Then 18 percent of the side with the higher vulnerability shoots first at the other side, and the survivors shoot back. The final attrition is the sum of the attrition from both steps.

In the following example, side A is the side with lower vulnerability.

First adjudication step:

$$\text{attrition}_B = \text{first-shot-fraction} \bullet \text{engaged-sorties}_A \\ \bullet \text{shots-per-sortie}_A \bullet \text{EK-per-shot}_A$$

$$\text{attrition}_A = \text{first-shot-fraction} \bullet (\text{engaged-sorties}_B - \text{attrition}_B) \\ \bullet \text{shots-per-sortie}_B \bullet \text{EK-per-shot}_B$$

Second adjudication step:

$$\text{attrition}_A = (1 - \text{first-shot-fraction}) \bullet \text{engaged-sorties}_B \\ \bullet \text{shots-per-sortie} \bullet \text{EK-per-shot}_B$$

$$\text{attrition}_B = (1 - \text{first-shot-fraction}) \bullet (\text{engaged-sorties}_A - \text{attrition}_A) \\ \bullet \text{shots-per-sortie}_A \bullet \text{EK-per-shot}_A$$

Allocating Attrition

Because the adjudication process fights each entire defending package against a fraction of each attacking sortie, defender attrition is simply posted against that package. Attacker attrition is allocated back to all attacking packages in proportion to their allocation divided by the average vulnerability of all attacking sorties. Thus, sorties that are more or less vulnerable than the average will take more or less attrition.

$$\text{attacker-package-attrition} = \text{total-attrition} \bullet \text{allocation-fraction} \\ \bullet \frac{\text{package-vulnerability}}{\text{average-vulnerability}}$$

Because this is a deterministic model, both fractional shots and fractional kills are allowed.

Sortie Suppression

For every DCA sortie killed by sweep or escort, an equal number of sorties are suppressed or rendered incapable of engaging strike packages. This represents DCA that has been drawn out of position by the sweep without getting shots.

BIASES IN THE JICM REPRESENTATION OF THE AIR WAR

Limiting sorties without AIM-120s or AA-12s to one engagement discounts the value of modern aircraft that carry as many as eight missiles. We felt that engagement opportunities in a small theater would be limited, with flight times from the edge of the PRC SA-10 envelope to targets no more than 20 minutes for the slowest aircraft. Conversely, the impact of BVR fire-and-forget missiles is magnified, with sorties carrying these weapons able to get as many as three times the kills as sorties without them.

The restriction that each sweep sortie engage no more than one DCA sortie is another potential bias. Model and time limitations prevented us from looking at a wider range of engaged sortie ratios, as well as uncertainty in how shot opportunities change in these cases. This ratio is as much a function of the DCA's ability to avoid the sweep as anything else, and could fall below 1:1 as well as rise above it. Lower ratios would allow more DCA to get to strikers, while higher ratios would result in more sweep attrition.

When ROC DCA engaged strike package escorts, we allowed up to a 2:1 engaged sortie ratio to represent the fact that DCA cannot evade escorts as easily. This allowed up to four shots to be taken at each escort, while allowing only two in return, resulting in extremely high escort attrition. While possibly biased against the escorts, we felt the disparity between DCA and escort quality made this a reasonable outcome.

The engaged sortie ratio limits also reduce the impact of changes in sortie quantities. Attrition in the sweep versus DCA engagement is essentially linear with the number of sorties on the smaller side—normally the sweep but in some cases the DCA. While the unengaged DCA goes on to engage the strike packages, the PRC gets no benefit

from unengaged sweep. In cases, however, in which the PRC has unengaged sweep, it is already winning the air war.

Aircraft quality enters into the model in a number of ways. As a training factor, quality multiplies lethality and has a linear effect on the sweep versus DCA engagement and up to a squared effect on DCA versus escorts. BVR missiles raise lethality by a factor of three but have more of an impact on ROC DCA that has more opportunities for engagements. DCA sorties that are limited to firing two shots at 0.5-vulnerability sweep sorties can fire the additional shots at escort and strikers. PRC AA-12 shooters have only one opportunity each to engage DCA and are limited to two shots against 0.5-vulnerability F-16As and Mirage 2000s, but can take up to 3.2 shots against 0.8-vulnerability IDFs. Still, in cases with advanced missiles the ROC DCA sorties will usually get more shots than the PRC sweep.

Aircraft air-to-air vulnerability is another measure of quality. It linearly reduces the number of sorties engaged and the shots that can be taken at a sortie but has a nonlinear effect on the fraction of sorties that get first shot, killing before being killed. We categorized the aircraft in the scenario into three vulnerability groups spaced well apart. Because of the shape of the first shot equation, small changes in vulnerabilities have little effect on aircraft that are already sizably different. Therefore, scenario outcomes are not strongly driven by small changes in the vulnerability scores of these groupings.

AIR DEFENSE ADJUDICATION

SAM engagements with air packages are adjudicated by a process similar to that for air-to-air engagements, with each SAM battery treated as an attacking package. Engagement rates are determined for both sides, attacking SAMs are allocated across defending packages, first shot calculations are made, and attrition assessed.

IADS Model

Since the JICM does not have an explicit model for the support of SAM batteries by an integrated air defense system (IADS), we implemented a simple parameter model in the JICM order scripting language. This model reduced ROC SAM effectiveness by half the percentage of damage done to Taiwan's 10 modeled early warning

radar sites. In all our cases, these radars were targeted by 20 DF-21 missiles and destroyed before the first air strike, resulting in a 50 percent effectiveness penalty to the ROC SAMs.

SEAD

In all our cases, PRC air did not fly SEAD missions because its most capable aircraft were involved in the air-to-air battle. Instead, TBMs with cluster warheads were fired at SAMs. In this analysis, we assumed that the ROC Patriots could not effectively intercept the modern PRC missiles. We also assumed that only 50 percent of the ROC SAMs were targetable by missiles on any given day due to movement or decoy measures.

OCA AND AI ADJUDICATION

On-Target Air-to-Ground Sorties

For each sortie lost on ingress another sortie aborts before attacking the target. This represents the loss in effectiveness caused by flying in an intense threat environment.

$$\text{abort-rate} = \text{loss-rate}$$

Air Base Attack

We modeled each of Taiwan's six air bases that support tactical aircraft as having one runway and four maintenance sites. In the JICM, air base sortie generating capability degrades as a function of damage to runways and maintenance sites, with a minimum (20 percent) below which the capability cannot be reduced.

$$\text{sortie-generation-rate} = 0.4 \bullet \text{maintenance-survival} + 0.2$$

This formulation requires attacks on both runways and maintenance to severely limit operations.

Air base repair is calculated according to the exponential functions:

$$\text{runway-percent-surviving} = 0.98 \bullet (1.0 - e^{(-0.1 \bullet t)})$$

$$\text{maintenance-percent-surviving} = 0.90 \bullet (1.0 - e^{(-0.01 \bullet t)}),$$

where t is the time spent repairing.

Maintenance repair is nearly linear, repairing at approximately 10 percent per day, to a maximum of 90 percent. Runway repair is more strongly nonlinear, repairing more than 30 percent in the first day when completely cut.

SCENARIO

ATO Creation

The JICM creates an ATO at the start of each day by assembling sorties into air-to-air and strike packages according to provided package definitions and other planning guidance. Table B.1 lists the package definitions for the missions used in this scenario.

Table B.1
Mission Packages

Side	Mission	Packages
U.S.	DCA	4 F-15C or F/A-18E/F
ROC	DCA	4 F-16A/Mirage 2000/IDF
PRC	DCA	4 J-7
	Sweep	4 Su-27/Su-30/J-10
	OCA or AI	4 H-6 and 4 escort
		8 JH-7/Q-5/J-7

Escorts for PRC strike packages were taken first from previous-generation fighters, leaving the modern PRC fighters for the sweep mission. J-7s flexed as required to fill out strike or escort roles.

Packages created at the start of the day were scheduled across the six four-hour periods. Table B.2 lists the percentages of packages by period.

Twenty-five percent of U.S. F-15C sorties and U.S. carrier sorties were withheld to provide air base and carrier defense. The small U.S. presence during night periods (1, 2, 6) was assumed to be flying combat air patrol (CAP) and escorting reconnaissance aircraft (not explicitly modeled). The U.S. F-15Cs out of Okinawa maintain a level effort CAP during the day periods because they are based too far

away to be completely reactive to PRC strikes. U.S. carrier air, which is closer, can concentrate more sorties in the two PRC strike periods.

ROC and U.S. land-based F-15Cs were allowed to surge to 150 percent of their base sortie rates for the first 48 hours of combat. PRC sorties surged 125 percent also for 48 hours, while U.S. carrier-based sorties did not surge.

Air-to-Air Combat

Each day’s air combat was fought in three periods, with strikes by the PRC in periods 3 and 5 and a smaller fighter sweep in between. With the base threat, the PRC strikes consist of approximately 90 sweep sorties, followed by 250 OCA and AI sorties with 90 escorts. With the advanced threat, the added advanced fighters boost sweep to 200 sorties per strike, while reducing OCA and AI to 200 sorties. ROC

**Table B.2
Package Timing**

Side	Mission	Period 1	2	3	4	5	6	Withheld
U.S.	DCA (F-15)	5	5	20	20	20	5	25
	DCA (F/A-18)	5	5	27	5	28	5	25
ROC	DCA	0	0	40	20	40	0	0
PRC	Sweep	0	0	40	20	40	0	0
	Strike	0	0	50	0	50	0	0

DCA flew 400 sorties against the first strike but was reduced by air base damage and attrition to 250 against the second.

Figure B.2 shows the D-day first strike sorties for the base case.

Figure B.3 shows the resulting sortie losses for each of the three periods, from air-to-air and ground-to-air (SAMs) combat.

Figure B.4 shows total aircraft losses and total sorties flown on D-day by aircraft type. The percentage of sortie losses is shown above the bars.

Ballistic Missiles

In the base case, we assumed that the PRC would launch the bulk of its missiles in two strikes on the first day of combat. Each missile strike preceded an air strike, for maximum effect on defending sorties. Twenty DF-15 missiles with both cluster and GPS-guided high-explosive warheads were fired at each of the six air bases with tactical

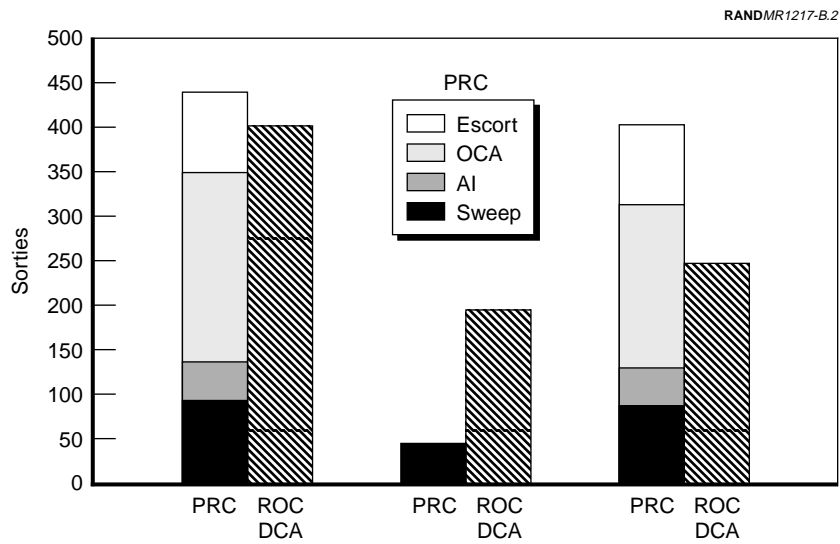


Figure B.2—D-Day Sorties

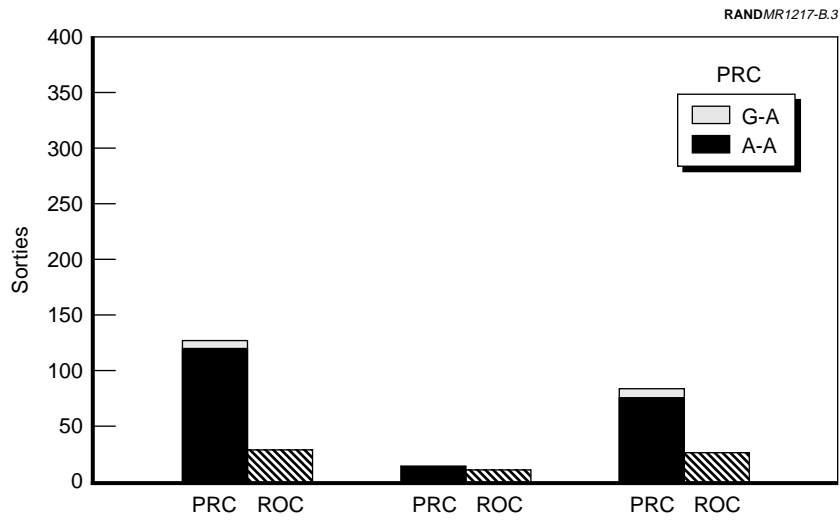


Figure B.3—D-Day Sortie Losses

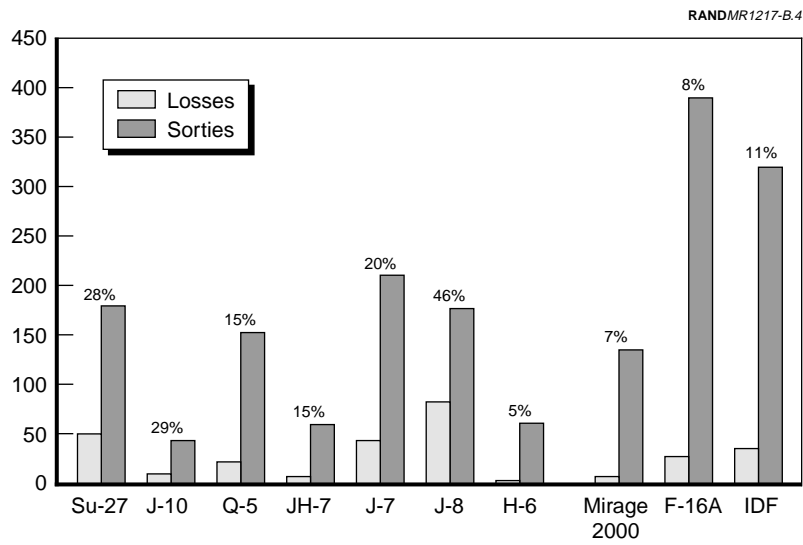


Figure B.4—D-Day Aircraft Losses and Sorties

aircraft, dropping air base sortie generation to 20 percent by the end of D-day (although overnight repairs raised sortie generation to 33 percent). Remaining DF-15s with cluster warheads were fired at known Patriot and Tien Kung SAM sites, killing six batteries on D-day. Twenty DF-21 missiles were fired at early warning radars, killing 10 sites and dropping ROC SAM effectiveness by 50 percent. DF-11 missiles were fired at landing preparation sites that were not explicitly modeled.

In cases with increased numbers of missiles, additional DF-15s with GPS guidance were used to restrike air base runways for two additional days, while additional DF-15s were used against SAM sites, killing more than 30 SAM batteries in four days.

Air-to-Ground Strikes

During the scenario, 80 percent of air strikes were directed against air bases. Dumb bombs were dropped against air base maintenance sites, GPS-guided munitions against runways, and laser-guided munitions with penetrating warheads against aircraft shelters. In the base case, high-altitude bombing with dumb weapons was largely ineffective and the numbers of PGMs were insufficient to change the outcome. In cases with increased numbers of PGMs, GPS-guided munitions were used both on runways and maintenance sites and were generally capable of reversing repair efforts. Because the missile attacks grounded many sorties, LGB attacks on shelters were reasonably effective, killing in the increased-munition, advanced-threat cases up to 35 aircraft in four days. In many cases, however, the ROCAF could prevent most of the strikes from reaching their targets.

Data

Table B.3 shows the key data used by the air model for Taiwan, PRC, and U.S. aircraft.

Sortie rate is a single number for each type of aircraft. It is not varied by the mission flown, although sortie rate multipliers are set for the region in which the squadron is based. In this case, the sortie rate for the U.S. F-15C is reduced because these aircraft are based in Okinawa.

Table B.3
Aircraft Data

Type	Sortie Rate	Air-to-Air Multiplier	Vulnerability	
			Air-Air	Ground- Air
Mirage 2000	2.0	.80	0.5	—
F-16A	2.0	.85	0.5/0.4	—
IDF	2.0	.85	0.8	—
Su-27	2.0	.90	0.5/0.4	0.5
Su-30	2.0	.90	0.5/0.4	0.5
J-10	1.5	.80	0.5/0.4	0.5
Q-5	1.0	—	1.0	1.0
JH-7	1.0	—	1.0	0.5
J-7	1.0	.80	1.0	1.0
J-8	1.0	.80	1.0	1.0
H-6	1.0	—	1.0	1.0
F/A-18E/F	2.0	.85	0.4	0.5
F-15C	1.6	.80	0.4	0.5

The **air-to-air multiplier** represents how the airframe of each aircraft type modifies the lethality of the weapons it carries.

Vulnerability represents how difficult the aircraft is to engage, both in air-to-air and ground-to-air combat. It primarily represents stealthiness, but it also includes performance, avionics, and weapon range. Vulnerabilities following slashes are the vulnerabilities employed when the aircraft carries an AIM-120 or AA-12 missile. Vulnerability has three effects in the model: it reduces the number of sorties that are engaged; it reduces the number of shots taken at the sortie; and it determines what fraction of sorties get first shot in an engagement.

We divided aircraft into four groups: modern aircraft with AIM-120s or AA-12s, other modern aircraft, previous-generation aircraft, and the Taiwan IDF. Table B.4 shows the engagement rates and first shot percentages derived for these groups.

Table B.4
Engagement Rates and First Shots

Type	Air-to-Air Vulnerability	First Shot Percentage Versus Adversary of Vulnerability			
		0.4	0.5	0.8	1.0
Modern with BVR	0.4	50.0	82.0	92.0	95.0
Modern	0.5	18.0	50.0	89.0	94.0
IDF	0.8	8.0	11.0	50.0	86.0
Old	1.0	5.0	6.0	14.0	50.0

Table B.5 shows the lethality scores for the air-to-air weapons used. The number of air-to-air weapons was unconstrained, except for Taiwan's 240 MICA missiles, which were exhausted after two days of combat. AIM-120 and AA-12 missiles were available to Taiwan and the PRC in some cases.

Air-to-air weapon lethality is represented as single-shot EK. These are not test range numbers, but rather the scores represent an average lethality across the kinds of engagements occurring in an air campaign. We chose to divide these air-to-air weapons into three categories for scoring: BVR missiles, other modern missiles, and the AA-2.

Table B.5
**Air-to-Air Weapon
Data**

Type	EK
AA-12	.70
AIM-120	.70
MICA	.70
AA-10	.35
AA-11	.35
AIM-9	.35
AIM-7	.35
AA-2	.17

Training factors are represented as multipliers on weapon EK, shown in Table B.6.

Weapon loads for each air-to-air mission are shown in Table B.7. Where more than one load is shown for a mission, loads are listed in order of preference.

The model uses an average EK per shot across the entire weapon load. The average EKs shown above also include the training factor and air-to-air multiplier.

Table B.6
Training Factors

Side	Factor
U.S.	1.0
Taiwan	0.8
PRC	0.5

Table B.7
Air-to-Air Weapon Loads

Type	Air-to-Air Loads	Shots	EK per Shot
Mirage 2000	2 MICA	2	0.45
F-16A	2 AIM-7	2	0.24
	2 AIM-9, 4 AIM-120	6	0.39
IDF	2 AIM-7	2	0.24
J-7	2 AA-2	2	0.06
J-8	2 AA-10	2	0.14
J-10	2 AA-10	2	0.14
	2 AA-11, 2 AA-12	4	0.21
Su-27	2 AA-10	2	0.15
	2 AA-11, 4 AA-12	6	0.26
Su-30	2 AA-10	2	0.15
	2 AA-11, 4 AA-12	6	0.26
F/A-18E/F	2 AIM-9, 4 AIM-120	6	0.49
F-15C	2 AIM-9, 4 AIM-120	6	0.46

Given the first shot percentages, exchange rates for selected aircraft are shown in Table B.8 as a point of comparison with mission-level models.²

Table B.9 shows the number and lethality scores for the air-to-ground weapons used by the PRC. Where there are two numbers for quantity, the larger number was used in cases with increased availability of PGMs or ballistic missiles. In the PGM-limited cases, GPS and LGBs are used up in two days of strikes against air bases. Only half the LGBs had penetrator warheads capable of busting shelters.

Air-to-ground lethality is represented as EKs against standard types of targets. Hard targets in this scenario are aircraft shelters, soft targets are early warning radars and landing preparation targets, area targets are air base maintenance sites, runways are air base runways, and SEAD targets are SAM batteries. SAM kills represent the kill of a single critical element, such as the radar or control vehicle. We assumed that there would be no reconstitution of SAM batteries within a four-day combat.

All air-to-ground attacks were made from high altitude to avoid short-range air defense systems.

Weapon loads for air-to-ground missions are shown in Table B.10. Where more than one load is shown for a mission, loads are listed in order of preference. Total load EKs are given for OCA against shelters, runways, and maintenance facilities; for AI against radars and

Table B.8
Air-to-Air Exchange Rates

Type	Su-27 with AA-12	Su-27	J-8
U.S. F-15C with AIM-120	2.1	6.3	53.5
ROC Mirage 2000 with MICA	1.2	3.6	5.5
ROC IDF	0.3	1.4	2.1

²These values were calculated by going through the attrition process with a single four-sortie package on each side.

Table B.9
Air-to-Ground Weapon Data

Weapon	Quantity	EK Hard	EK Soft	EK Area	EK Runway	EK SAM
GPS-guided (800-kg)	200/2,000		0.71	0.12	0.06	
Laser-guided (800-kg)	50/500	0.35	0.65	0.25		
Cluster (500-kg)	—		0.01	0.007		
Dumb (250-kg)	—	0.03	0.005	0.004		
DF-21	80/160		1.00			
DF-11	50/100		1.00			
DF-15 cluster	80/200			0.50		0.33
DF-15 GPS-guided	80/120				0.08	

landing preparation sites; and for SEAD against SAM batteries. These EKs include the training factor from Table B.6.

Table B.11 shows the number of ROC SAM batteries and their EKs versus high-altitude aircraft. In all cases, we assumed that the ROC Patriots, which were sited at air bases, could not intercept the more modern missiles that were fired at them.

Table B.10
Air-to-Ground Weapon Loads

Aircraft	Load for OCA	EK Shelter	EK Runway	EK Maintenance
Q-5/J-7	4 dumb			0.016
JH-7	2 GPS		0.12	0.24
	2 LGB	0.76		0.50
	4 dumb, 4 cluster			0.044
H-6	12 dumb			0.048
	3 GPS		0.36	

Table B.11
Ground-to-Air Weapon Data

Type	Quantity (Battery)	EK versus Aircraft
Patriot PAC-2	9	0.7
Tien Kung	6	0.7
Hawk	36	0.4