

# Operation Barbarossa: the Complete Organisational and Statistical Analysis, and Military Simulation

## Volume I

### Table of Contents

List of Diagrams, Graphs and Tables .....	1
List of Abbreviations .....	6
Introduction .....	1
<b>Part I - The Concepts and General Structure of the Integrated Land and Air Resource Model.....</b>	<b>5</b>
<b>1. Studying Military History Using Operational – Strategic Simulations.....</b>	<b>5</b>
1) The Evolution of Military Simulations and War Gaming .....	5
2) The Power of Military Simulations in the Study of Military History .....	8
3) The Difference between Qualitative and Quantitative Analyses .....	10
4) Tactical, Tactical-Operational, Operational and Strategic Military Simulations .....	12
a. Tactical Level Simulations.....	12
b. Tactical-Operational Level Simulations.....	12
c. Operational Level Simulations.....	13
d. Strategic Level Simulations .....	16
<b>2. The Integrated Land and Air Resource Model.....</b>	<b>19</b>
1) What is an Integrated Land and Air Resource Model (ILARM)?.....	19
a. The Underlying Principles .....	19
b. The Fully Integrated Land and Air Resource Model (FILARM).....	20
c. The Partially Integrated Land and Air Resource Model (PILARM).....	20
d. Naval Forces Involved in Operation Barbarossa.....	20
2) The Objectives of the Integrated Land and Air Resource Model.....	22
a. The Strategic Context of the Military Campaign: Bottlenecks in the Mobilisation Process .....	22
b. The Actual Personnel and Equipment Present .....	24
c. Combat Unit Mobility .....	24
d. Efficiency of Supporting Infrastructures .....	25
e. Replacements .....	25
f. New Equipment.....	26
g. Operational Freedom of Action .....	27
<b>3. The Structure of the Fully Integrated Land and Air Resource Model (FILARM)....</b>	<b>29</b>
1) Resource Sources, Destinations and Paths outside the FILARM Model .....	31
2) Resource Reallocation Paths within the FILARM Model.....	32
3) Resource Allocation States inside the FILARM Model.....	34
a. Combat Units: D, MD and MND.....	34
i. Deployed (D) .....	34
ii. Mobilised and Deployed (MD) .....	34
iii. Mobilised and Not Deployed (MND).....	34
b. Supply and Support Infrastructure .....	35
c. Reserves and Replacements (R).....	36
i. Replacements (R).....	36
ii. Campaign Start Reserves .....	36
iii. Campaign Reserves.....	37
4) Combat Unit Processes inside the FILARM Model.....	39
a. Checking the TOE Authorisation of a Deployed (D) Combat Unit .....	39

b.	Check the TOE Authorisation of a MD or MND Combat Unit .....	40
c.	The Combat Process .....	40
i.	Key Terms and Concepts used in the Combat Process .....	41
ii.	Outcomes of the Combat Process .....	41
d.	The Attrition Process .....	43
i.	Outcomes of the Attrition Process .....	43
e.	The Disband and Shatter process .....	45
i.	Combat Unit Shattering .....	45
ii.	Combat Unit Disbandment.....	46
<b>4.</b>	<b>The Structure of the Partially Integrated Land and Air Resource Model (PILARM).....</b>	<b>49</b>
1)	Resource Sources, Destinations and Paths outside the PILARM Model .....	51
2)	Resource Allocation States inside the PILARM Model.....	52
a.	Combat Units: D and Reinforcement Units .....	52
i.	Deployed (D) .....	52
ii.	Reinforcement Units .....	52
b.	Reserves and Replacements (R).....	52
i.	Replacements (R).....	52
ii.	Front Campaign Reserves .....	52
3)	Combat Unit Processes inside the PILARM Model.....	53
a.	Check the TOE Authorisation of a Reinforcement Combat Unit.....	53
<b>5.</b>	<b>The Order of Battle (OOB): the Force Deployment Matrices.....</b>	<b>55</b>
<b>6.</b>	<b>Tables of Organisation and Equipment (TOE) .....</b>	<b>57</b>
1)	TOE Representation in a Table Format.....	57
<b>7.</b>	<b>The Heterogeneous vs. the Homogeneous Model.....</b>	<b>65</b>
1)	The Heterogeneous Model .....	66
2)	The Homogeneous Model and the use of Checksums .....	66
<b>8.</b>	<b>Supply Distribution Efficiency (SDE).....</b>	<b>69</b>
1)	Supply Lift .....	70
2)	Supply Demand.....	71
<b>9.</b>	<b>A Divisional Sized or Division Equivalent Combat Unit in WWII.....</b>	<b>73</b>
1)	What was a Divisional Sized Combat Unit in 1941?.....	73
2)	Measuring Whether a Combat Unit can Reasonably be Called a Divisional Sized Combat Unit.....	77
<b>Part II – The Methodology Used for Analysing Weapon System Effectiveness, and the Structure of the 1941 Soviet and Axis Resource Database .....</b>		<b>81</b>
<b>1.</b>	<b>The Database Resolution Level.....</b>	<b>81</b>
1)	Database Unit Resources in the Integrated Land and Air Resource Model.....	83
<b>2.</b>	<b>Methodology for Calculating a Weapon System’s or Database Unit’s Overall Combat Power Coefficient (OCPC) .....</b>	<b>85</b>
1)	Calculating Individual Weapon Combat Power Coefficients (WCPCs).....	85
a.	Rate of Fire (RF).....	85
b.	Number of Potential Targets per Strike (PTS).....	87
c.	Relative Incapacitating Effect (RIE).....	89
d.	Range Factors (RN) .....	90
e.	Accuracy (A).....	91
f.	Reliability (RL).....	92

g.	Self-Propelled Artillery Factor (SPA).....	92
h.	Aircraft Mounted Weapon Effect (AE).....	92
i.	Multi Barrelled Effect (MBE).....	94
j.	Typical Target Dispersion Factor (TDi).....	94
2)	Calculating a Non-Mobile Weapon System's or Squad's Overall Combat Power Coefficient (OCPC).....	96
a.	Tactical Responsiveness Factor (TRF) .....	96
b.	Fire Control Effect (FCE) .....	97
c.	Concealment and Protection Factor (CPF).....	97
d.	Defensive Dispersion Factor (DDF) .....	97
3)	Calculating a Land Based, Motorised Mobile Fighting Machine's (MFM's) Overall Combat Power Coefficient (OCPC).....	98
a.	MFM Weapons and Multi Barrelled Effect rules.....	98
b.	Battlefield Mobility Factor (MOF) .....	99
c.	Range of Action (RA) .....	100
d.	Protection Factor (PR) .....	100
e.	Shape and Size Factor (SSF).....	104
i.	SSF Modifications due to Sloped Armour .....	104
ii.	SSF Modifications due to Size, Height and Shot Traps .....	107
f.	Open Top Factor (OTF) .....	110
g.	Rapidity of Fire Effect (RFE) .....	110
h.	Fire Control Effect (FCE) .....	113
i.	Turret Crew Efficiency (TCE) .....	115
ii.	Main gun Optics Quality (OPQ) .....	117
iii.	Turret Basket Effect (TBE).....	117
iv.	Turret Drive Reliability (TDR) .....	118
v.	Target observation and Indicator Devices (TID).....	118
i.	Ammunition Supply Effect (ASE) .....	120
j.	Half Track-Wheeled Effect (WHT) .....	122
4)	Calculating an Aircraft's Overall Combat Power Coefficient (OCPC) .....	123
a.	Aircraft Mounted Weapons and Multi Barrel Effect Rules.....	123
b.	Aircraft Launched Weapons .....	124
c.	Battlefield Mobility Factor (MOF) .....	124
d.	Radius of Action (RA) .....	125
e.	Durability Factor (DUR).....	125
f.	Aircraft Shape and Size Factor (SSF) .....	126
g.	Maximum speed and Manoeuvrability Factor (SpMvr).....	126
h.	Ceiling Effect Factor (CL) .....	127
<b>3.</b>	<b>Methodology for Calculating a Weapon System's or Database Unit's Specific Combat Attributes .....</b>	<b>129</b>
1)	Relative Overall Attack Factor (ATT) and Relative Overall Defence Factor (DEF).....	130
2)	Effective Combat Ranges (R) and Aircraft Combat Radius (R) .....	132
3)	Relative Anti-Personnel Value (APer).....	134
4)	Relative Anti-Armour Value (AT).....	135
a.	Relative Anti-Armour Value (AT) for Land Based Weapon Systems and Squads.....	135
b.	Relative Anti-Armour Value (AT) for Aircraft.....	137
5)	Relative Anti-Aircraft Value (AA).....	138
a.	Relative Anti-Aircraft Value (AA) for Land Based Weapon Systems and Squads .....	138
b.	Relative Anti-Aircraft Value (AA) for Aircraft .....	140
6)	Relative Fortification Destruction Effect (FDE).....	141
7)	Relative Armour Defence Strength (ARM) .....	143
8)	Relative Assault Defence Strength (ADS) and Relative Assault Attack Strength (AAS) ...	144

TOC Volume 1

a.	Relative Assault Defence Strength (ADS).....	145
b.	Relative Assault Attack Strength (AAS).....	146
9)	Relative Overall Mobility (MOB).....	148
10)	Supply Demand Factor (SDF).....	150
a.	SDF Values for Land Based Weapon Systems and Squads .....	150
b.	SDF Values for Aircraft.....	152
<b>4.</b>	<b>Resource Database Comments and Conclusions .....</b>	<b>153</b>
<b>Appendix A</b> .....		<b>155</b>
	Armour Penetration Figures: Historical Test Results vs. Calculated Values.....	155
<b>Appendix B</b> .....		<b>163</b>
	Combat Aircraft versus Armour during WWII: Factors to Consider in Calculating Aircraft Relative Anti-Armour Values (AT).....	163
<b>Appendix C</b> .....		<b>171</b>
	Table of Contents, Volume IIA: The German Armed Forces (Wehrmacht), Mobilisation and War Economy from June to December 1941.....	171
<b>Appendix D</b> .....		<b>179</b>
	Table of Contents, Volume IIB: The German Armed Forces (Wehrmacht), Mobilisation and War Economy from June to December 1941.....	179
<b>Appendix E</b> .....		<b>183</b>
	Table of Contents, Volume IIIA: The Soviet Armed Forces, Mobilisation and War Economy from June to December 1941.....	183
<b>Appendix F</b> .....		<b>189</b>
	Table of Contents, Volume IIIB: The Soviet Armed Forces, Mobilisation and War Economy from June to December 1941.....	189
	<b>Selected Bibliography</b>	

## List of Diagrams, Graphs and Tables

Model Type Employed for each of the Combatant's Land, Sea and Air Forces .....	20
General Structure of the Fully Integrated Land and Air Resource Model (FILARM) .....	30
General Structure of the Partially Integrated Land and Air Resource Model (PILARM) .....	50
Deployment Matrix Example: German 18th Army in Army Group North on 22nd June 1941 ....	55
Soviet Rifle Division TOE Organisation, 5th April 1941 - Chart Format .....	58
Soviet Rifle Division TOE Organisation, 5th April 1941 - Table Format.....	59
Table of the Most Common Abbreviations used for TOE Tables .....	61
A Comparison of Personnel and Equipment in Rifle - Infantry Divisions, 1941 .....	76
Comparison of 1941 Divisions with the Minimum Divisional Size (MDS) Value .....	79
Rates of Fire vs Weapon Calibre, for Non-Automatic and Non-AA Weapons .....	86
Number of Potential Targets per Strike vs Weapon Calibre.....	88
Average Relationship of Bomb Weight to Artillery Calibre .....	89
Fire Control Effect for Non-Mobile Direct Fire Weapon Systems.....	97
Average Number of Hits to Knock out Each Type of Tank (Western Europe, 1944-45).....	102
Distribution of AP Penetrations and AP Failures on German Panzer V (Panther).....	103
Typical Armour Penetration Reduction vs Slope from Vertical.....	105
Mobile Fighting Machine's (MFM's) Principal Weapon Rapidity of Fire Effect.....	111
The Effect of Turret Crew Numbers on Turret Crew Efficiency (TCE).....	116
Armoured Fighting Vehicle Ammunition Supply Effect (ASE) Factor .....	121
Air Launched Weapons vs Equivalent Anti-Armour Performance .....	137
Aircraft Supply Demand Factors (SDF) .....	152
Calculated Armour Penetration Values vs Historical Test Data.....	157

## List of Abbreviations

A	Accuracy	DUR	Aircraft Durability Factor
A Cars	Armoured Cars	EnB	Engineering Battalion
AA	Anti-Aircraft and Relative Anti-Aircraft Value	EnC	Engineering Company
AAB	Anti-Aircraft Battalion	Eng	Engineering
AAC	Anti-Aircraft Company	EnP	Engineering Platoon
AAG	Anti-Aircraft Gun	EnR	Engineering Regiment
AAMG	Anti-Aircraft Machine Gun	FCE	Fire Control Effect
AAP	Anti-Aircraft Platoon	FDE	Relative Fortification Destruction Effect
AAS	Relative Assault Attack Strength	FILARM	Fully Integrated Land and Air Resource Model
AcCo	Armoured Car Company	GPMG	General Purpose Machine Gun
ADS	Relative Assault Defence Strength	Gun/Can	Gun/Cannon
AE	Aircraft Mounted Weapon Effect	HAR	Heavy Artillery Regiment
AFV	Armoured Fighting Vehicle	HCavS	Heavy Cavalry Squadron
AP	Armour Piercing	HIC	Heavy Infantry Company
APC	Armour Piercing Capped	HMG	Heavy Machine Gun
APC	Armoured Personnel Carrier	How	Howitzer
APCBC	Armour Piercing Capped Ballistic Capped	HQ	Headquarter
APer	Relative Anti-Personnel Value	HR Sqd	Heavy Rifle (or Infantry) Squad
ArB	Artillery Battalion	HRC	Heavy Rifle Company (w HMGs &/or mortars)
ARM	Relative Armour Defence Strength	I Bat	Infantry Battalion
ArP	Artillery Platoon (or Battery)	I Div	Infantry Division
ArR	Artillery Regiment	I Reg	Infantry Regiment
ASE	Ammunition Supply Effect	ICo	Infantry Company
ASig Pl	Armoured Signal Platoon	ILARM	Integrated Land and Air Resource Model
AT	Anti-Tank and Relative Anti-Armour Value	InG Co	Infantry Gun Company
ATB	Anti-Tank Battalion	InG P	Infantry Gun Platoon (or Battery)
ATC	Anti-Tank Company	IPI	Infantry Platoon
ATG	Anti Tank Gun	LAR	Light Artillery Regiment
ATP	Anti-Tank Platoon (or Battery)	LMG	Light Machine Gun
ATT	Relative Overall Attack Factor	LR Sqd	Light Rifle Squad
B Sup	Battalion Support	LS	<i>Landesschutzen</i> , (Local Defence Unit)
BicBat	Bicycle Battalion	LS Reg	<i>Landesschutzen</i> Regiment
Br	Bridging	MAR	Medium Artillery Regiment
BrB	Bridging Battalion (pontoon)	MBE	Multi Barrelled Weapon Effect
BrC	Bridging Company (pontoon ) or Bridging Column (pontoon)	MD	Mobilised and Deployed
BrCB	Bridge Construction Battalion	MDS	Minimum Divisional Size
Bri Sup	Brigade Support	MFM	Motorised Mobile Fighting Machine
BrP	Bridging Platoon (pontoon)	MG Bat	Machine Gun Battalion
Cav	Cavalry	MG/Art Bat	Machine Gun and Artillery Battalion
Cav B	Cavalry Battalion	MgCo	Machine Gun Company
Cav Brig	Cavalry Brigade	MgPl	Machine Gun Platoon
Cav Reg	Cavalry Regiment	MGS	Machine Gun Squadron
CavP	Cavalry Platoon	MGT	Machine Gun Troop
CavS	Cavalry Squadron	MMG	Medium Machine Gun
CavSC	Cavalry Support Company	MND	Mobilised and Not Deployed
CavT	Cavalry Troop	MoB	Mortar Battalion
CL	Aircraft Ceiling Effect Factor	MOB	Relative Overall Mobility
Cons Bat	Construction Battalion	MoC	Mortar Company
CP	Concealment and Protection Factor	MoCyBat	Motor Cycle Battalion
D	Deployed	MoCyCo	Motor Cycle Company
D Sup	Divisional Support	MoCyPl	Motor Cycle Platoon
DDF	Defensive Dispersion Factor	MOF	Battlefield Mobility Factor (for land units and aircraft)
DEF	Relative Overall Defence Factor	MoP	Mortar Platoon (or Battery)

100 Volume 1

Mor	Mortar	SaP	Sapper/Pionier Platoon
MP	Military Police	SapS	Sapper Squadron
MPBat	Military Police Battalion	SchBat	<i>Schnell</i> Battalion (Fast Battalion)
NerW Bat	<i>Nerbelwerfer</i> Battalion	SDE	Supply Distribution Efficiency
OCPC	Overall Combat Power Coefficient	SDF	Supply Demand Factor
OOB	Order of Battle	Sig B	Signal Battalion
OPQ	Main-gun Optics Quality	Sig C	Signal Company
OTF	Open Top Factor	Sig Pl	Signal Platoon
PiC	Pionier Company	SMG	Sub Machine Gun
PILARM	Partially Integrated Land and Air Resource Model	SMGC	Sub Machine Gun Company
PR	Protection Factor	SPA	Self-Propelled Artillery Factor
PTS	Number of Potential Targets per Strike	SpMvr	Aircraft Maximum Speed and Manoeuvrability Factor
Pz	Panzer	Sqd	Squad
QJM	Quantified Judgement Model	SSF	Shape and Size Factor (for land units and aircraft)
R	Effective Combat Ranges or (Aircraft) Combat Radius, and Replacements	StuGC	StuG Company (German assault gun co)
R Bat	Rifle Battalion	StuGP	StuG Platoon (German assault gun platoon)
R Div	Rifle Division	TankB	Tank Battalion (or Panzer Battalion)
R Reg	Rifle Regiment	TankC	Tank Company (or Panzer Company)
R Sqd	Rifle (or Infantry) Squad	TankP	Tank Platoon (or Panzer Platoon)
R Sup	Regimental Support	TankR	Tank Regiment (or Panzer Regiment)
RA	Range of Action for land units, or Radius of Action for aircraft	TankS	Tank Squadron
RARB	Rocket Artillery Battalion	TBE	Turret Basket Effect
RARP	Rocket Artillery Platoon (or Battery)	TCE	Turret Crew Efficiency
RCo	Rifle Company	TDi	Typical Target Dispersion Factor
ReB	Reconnaissance Battalion	TDR	Rotating Turret y/n, and Turret Drive Reliability
ReC	Reconnaissance Company	TID	Target observation and Indicator Devices
ReP	Reconnaissance Platoon	TNDM	Tactical Numerical Deterministic Model
RF	Rate of Fire	TOE	Tables of Organisation and Equipment (Soviet - Shtaty and German - KStN)
RFE	Rapidity of Fire Effect	Tra	Transport Infrastructure
RIE	Relative Incapacitating Effect	TRF	Tactical Responsiveness Factor
RL	Reliability Factor	W	<i>Wach</i> (Watch)
RN	Range Factors	W Bat	<i>Wach</i> Battalion
ROCP	Relative Overall Combat Proficiency	WCPC	Weapon Combat Power Coefficient
RPl	Rifle Platoon	WHT	Half Track/Wheeled Effect
SaB	Sapper/Pionier Battalion		
SaC	Sapper Company		