

**THE BEGIN-SADAT CENTER FOR STRATEGIC STUDIES
BAR-ILAN UNIVERSITY**

Mideast Security and Policy Studies No. 150

The Israel Defense Forces, 1948-2017

Kenneth S. Brower

The Israel Defense Forces, 1948-2017

Kenneth S. Brower

© The Begin-Sadat Center for Strategic Studies
Bar-Ilan University
Ramat Gan 5290002 Israel
Tel. 972-3-5318959
Fax. 972-3-5359195

office@besacenter.org
www.besacenter.org
ISSN 0793-1042

May 2018

Cover image: Soldier from the elite Rimon Battalion participates in an all-night exercise in the Jordan Valley, photo by Staff Sergeant Alexi Rosenfeld, IDF Spokesperson's Unit

The Begin-Sadat (BESA) Center for Strategic Studies

The Begin-Sadat Center for Strategic Studies is an independent, non-partisan think tank conducting policy-relevant research on Middle Eastern and global strategic affairs, particularly as they relate to the national security and foreign policy of Israel and regional peace and stability. It is named in memory of Menachem Begin and Anwar Sadat, whose efforts in pursuing peace laid the cornerstone for conflict resolution in the Middle East.

Mideast Security and Policy Studies serve as a forum for publication or re-publication of research conducted by BESA associates. Publication of a work by BESA signifies that it is deemed worthy of public consideration but does not imply endorsement of the author's views or conclusions. *Colloquia on Strategy and Diplomacy* summarize the papers delivered at conferences and seminars held by the Center for the academic, military, official and general publics. In sponsoring these discussions, the BESA Center aims to stimulate public debate on, and consideration of, contending approaches to problems of peace and war in the Middle East. The *Policy Memorandum* series consists of policy-oriented papers. The content of the publications reflects the views of the authors only. A list of recent BESA Center publications can be found at the end of this booklet.

International Advisory Board

Founder of the Center and Chairman of the Advisory Board: Dr. Thomas O. Hecht

Vice Chairman: Mr. Saul Koschitzky

Members: Prof. Moshe Arens, Ms. Marion Hecht, Mr. Robert Hecht, Prof. Riva Heft-Hecht, Hon. Shlomo Hillel, Mr. Joel Koschitzky, Amb. Yitzhak Levanon, Sen. Joseph I. Lieberman, Mr. Robert K. Lifton, Rt. Hon. Brian Mulroney, Mr. Seymour D. Reich, Mr. Greg Rosshandler, Amb. Zalman Shoval, Amb. Norman Spector, Ms. Drorit Wertheim

International Academic Advisory Board

Prof. Ian Beckett *University of Kent*, Dr. Eliot A. Cohen *Johns Hopkins University*, Prof. Irwin Cotler *McGill University*, Prof. Steven R. David *Johns Hopkins University*, Prof. Lawrence Freedman *King's College*, Prof. Patrick James *University of Southern California*, Prof. Robert J. Lieber *Georgetown University*, Prof. Michael Mandelbaum *Johns Hopkins University*

Research Staff

BESA Center Director: Prof. Efraim Karsh

Research Associates: Dr. Efrat Aviv, Dr. Yael Bloch-Elkon, Brig. Gen. (res.) Moni Chorev, Dr. James Dorsey, Dr. Gil Feiler, Prof. Jonathan Fox, Prof. Hillel Frisch, Dr. Manfred Gerstenfeld, Prof. Eytan Gilboa, Maj. Gen. (res.) Gershon Hacohen, Col. (res.) Aby Har-Even, Eado Hecht, Dr. Tsilla Hershco, Dr. Doron Itzhakov, Lt. Col. (res.) Dr. Mordechai Kedar, Mr. Yaakov Lappin, Prof. Udi Lebel, Dr. Alon Levkowitz, Prof. Ze'ev Maghen, Ambassador Arye Mekel, Lt. Col. (res.) Dr. Raphael Ofek, Col. (res.) Mr. Uzi Rubin, Dr. Jonathan Rynhold, Prof. Shmuel Sandler, Maj. Gen. (ret.) Dr. Emanuel Sakal, Dr. Eitan Shamir, Lt. Col. (res.) Dr. Dany Shoham, Prof. Shlomo Shpiro, Dr. Max Singer, Prof. Joshua Teitelbaum

Publications Editor (Hebrew): Alona Briner Rozenman

Publications Editor (English): Judith Levy

The Israel Defense Forces, 1948-2017

Table of Contents

Executive Summary	5
Introduction	6
Armored Corps	11
Paratroops and Infantry	20
Artillery and Anti-Tank	23
Air Defense	29
Air Force	32
Navy	43
Discussion	47
Conclusion	52
Notes	55
Bibliography	68

The Israel Defense Forces, 1948-2017

Kenneth S. Brower

EXECUTIVE SUMMARY

This study explores the evolution of the order of battle, material holdings and capability of the Israel Defense Forces (IDF) since their establishment seventy years ago. During this period, the IDF has transitioned from an ill-equipped and low-quality militia to a dominant regional military power. Recent cutbacks in the IDF's order of battle notwithstanding, Israel can still deploy ground forces equipped with the world's largest concentration of operational armored vehicles. It has an exceedingly advanced tactical air force capable of generating nearly 2,000 daily fast-jet combat sorties, and is protected by the world's most advanced and dense national air defense system. It has an effective coastal navy that deploys exceptionally well-armed, advanced small combatants and attack submarines; it has a significant strategic and tactical nuclear capability; and it likely maintains the world's third-largest inventory of nuclear weapons.

By way of understanding this extraordinary development, the study describes the evolution of each of the IDF's combat arms while explaining how Israel's longstanding, all-encompassing, national military doctrine, and resulting use of universal conscription and compulsory reserve service, have permitted a relatively small country of limited resources to generate vastly disproportionate military capability at a remarkably low annual budgetary cost.

Assessing the current state of Israel's military forces and its short- and long-term implications, the study argues that the IDF has been seriously underfunded in recent years with the attendant decline in the readiness of its current reserve forces. It also argues that the IDF's order of battle has been too deeply cut and that its force structure has been overly optimized to address the current threat of non-state asymmetric warfare. Most significantly, it argues that the IDF is not giving due consideration to potential future changes in the stability of currently non-hostile neighbors and, therefore, has seriously underestimated the probability of large-scale conventional warfare in the foreseeable future.

Kenneth S. Brower is a naval architect and defense analyst specializing in the interaction of technology and tactics and the Middle Eastern military balance.

The Israel Defense Forces, 1948-2017

Kenneth S. Brower

INTRODUCTION

For over sixty years, international assessments of the material holdings, order of battle and capability of the Israel Defense Forces (IDF) have consistently been underestimated. This has reflected a combination of factors, including very effective Israeli security, the imposition of military censorship on the Israeli media, the continuous Israeli dissemination of generally accepted disinformation, and, often, the complete lack of understanding by outsiders of Israel's military doctrine and the impact of its relatively unique defense system.¹

After the collapse of the Soviet Union, Israel remains one of the few states that still have an all-encompassing national military doctrine, which impacts every aspect of its national security. For example, such things as civilian building codes, the import and licensing of civilian trucks (which would be mobilized by the military in wartime), the design and capability of all hospitals, and even the civilian education system (which provides the trained professionals needed by the military) are all impacted. Therefore, a national military doctrine has far broader consequences than just the design of the nation's military forces.

Israel's early political-military leadership understood that it could not occupy its much larger neighbors, which made the goal of unconditional victory virtually unattainable. It also recognized that cold war realities and superpower strategic interests meant that Israel could not force its neighbors to accept its terms for a termination of hostilities. Therefore, it was recognized that a victorious war would not lead to peace but was only a steppingstone to future conflict. These realities meant that achieving quick, decisive military victories at low human cost became a strategic imperative for national survival, which would always depend

on maintaining regional military superiority. As a result of this realistic assessment, Israel's military doctrine, as developed at the creation of the state, has long been strategically defensive and operationally offensive. This required that the IDF have the ability to rapidly mobilize a very high readiness and large order of battle designed to quickly achieve decisive military results. Given Israel's limited financial and human resources, this objective could only be accomplished by the use of universal conscription followed by compulsory reserve service. Israeli national defense doctrine, developed in 1949-50 and not changed since, has had a dominating impact on the military's mobilizable order of battle, the equipment mix used by the IDF, and Israel's military capability. Israel's continued use of universal conscription and compulsory reserve service has inevitably resulted in it being able to rapidly deploy a disproportionately large and relatively well-trained, combat-ready order of battle at amazingly low annual budgetary cost. Since the late 1960s, it has been able to acquire advanced US weaponry, as well as the products of its own, now cutting edge, military-industrial complex. But the constraints of limited budgets have inevitably meant that the IDF has always employed a high-low force mix. Today, the IDF is among the most advanced, if not the most advanced and capable, regional military force in the world.²

As first conceived, the primary purpose of the IDF's conscript-filled active force structure was the generation of fully trained, experienced, reserve personnel. After leaving active duty, Israeli reservists would subsequently serve until they reached middle age, generally performing the same military specialties assigned upon conscription. It was initially planned that reserve combat personnel would use the same equipment and battle drill tactics they had employed during their rigorous training as conscripts. The active force structure, with a limited number of contracted senior officers and specialized non-commissioned officers, plus conscripted junior officers and enlisted personnel, therefore represents only a small proportion of the mobilizeable wartime order of battle. IDF reserve units are generally stable, with very limited personnel turnover, a consistent table of organization (TOE), employing the same basic equipment, and conducting the same "battle drill" tactics they had learned when on active duty. By comparison, the IDF's active conscript-filled units are unstable. They will be constantly turning over personnel

as newly inducted conscripts begin their service, replacing other fully trained conscripts who leave active service and enter the reserves. The TOE, equipment and tactics of active units are all continuously subject to change as the IDF experiments, introduces new equipment into service, and as General Staff priorities change.

After the June 1967 war, IDF conscript units were required to man frontline defensive positions during an ongoing war of attrition. This inevitably led to a progressive lengthening of enlisted male conscript service from 24 to 36 months, primarily to increase the number of active units available for day-to-day border defense. Initial Israeli experience also resulted in a requirement for those selected for promotion to officers to volunteer to serve an additional year of conscripted service. This permitted young junior officers to accrue active experience as platoon commanders before transitioning into the reserves. The increase in the number of conscripts inducted annually, plus the significantly reduced threat of a large-scale surprise attack, has combined to recently permit a reduction in the length of male conscript service to 32 months. It is assessed that decades of continuous emphasis on internal security operations has inevitably reduced the capability and readiness of both conscript and reserve units for high intensity conventional maneuver warfare.

In the early 1990s, Israeli reserves conducted nearly 10 million man-days of annual service. Over the next decade, with the destruction of the Iraqi military and the growing obsolescence of the Syrian military, reserve duty was progressively reduced to about 5 million man-days annually. Between 2000 and 2006, reservists were rarely called up for training. Moreover, during this period, conscript units also virtually ceased unit field training. Therefore, the IDF ground forces that went to war in 2006 against Hezbollah were a mediocre shadow of what they used to be. Today, IDF conscript units are, again, receiving large scale field training, but with far fewer live fire exercises. IDF reservists now only receive about 2,000,000 man-days of training annually, far less than in the past, and they also conduct far fewer live fire exercises. Israeli infantry reserves, in particular, have inadequate readiness, as they are only called up every third year for training. This is assessed to be grossly inadequate.

Unlike the ground forces, Israeli Air Force (IAF) and Navy units have always been primarily active, not reserve. However, both the IAF and

the navy require the mobilization of reserve personnel to reach their full wartime strength. Depending on the availability of serviceable airframes and qualified aircrew, the IAF has often included reserve combat squadrons in its wartime order of battle. The aircraft for these reserve squadrons have been maintained in fully serviceable storage. For example, in the 1980s and 1990s, many Phantoms, Skyhawks and Kfirs were stored in environmentally protected, dehumidified cocoons for three months, broken out of storage, flown briefly, serviced, and re-cocooned.³

In the past, the IDF proved able to thrust its high readiness reserves into combat within as little as 24-48 hours from mobilization. Unless Israeli political and military leaders are willing to accept disproportionately high military casualties, this is no longer generally feasible. Most Israeli ground force reserve units would now require at least one week, and preferably considerably longer, of refresher field training before being committed to combat with anything approaching adequate readiness. The combat readiness levels of current Israeli reserves are, therefore, significantly lower than that of previous generations.⁴

Because of its national defense doctrine, the size of the IDF's mobilizeable order of battle has been primarily influenced by long term variations in the number of conscripts inducted annually, subsequent wastage due to unsuitability, illness or emigration, changes in military missions, the impact of technology, and, most significantly, by the availability of funding for both the training of reservists and the simultaneous acquisition of advanced weapon systems and war reserve ammunition and spares. For nearly five decades, reserve enlisted service has historically extended for a minimum of 21 years after completion of an initial three-year conscription. This means that at anytime during Israel's existence, the mobilizeable order of battle would theoretically be up to eight times larger than the average annual conscript-filled active force structure that had existed during the previous 21 years. Based on prior experience, this ratio has actually varied between about five to seven. The lower ratio was particularly applicable between 1968 and 1980, during a period of rapid growth in the active force structure, before the cumulative number of reserves being generated annually could swell the number of mobilizeable reserve brigades. Over the long term, any modifications in the active structure of the ground forces will significantly impact the future mobilizeable force structure. As a result of the inevitable

disestablishment of reserve units having over-age personnel, the IDF general staff must continuously decide whether to recycle the equipment held in storage for the use of the reserve units that are being deactivated for another lengthy cycle of service.⁵

Typically, the obsolescent material held in storage for the use of recently deactivated reserve units continued to be held in storage as emergency war reserves. This material could be rapidly reactivated, and used to replace war losses or create additional units in an emergency. After a period of years, when the over-age reservists who had once employed these weapon systems were beyond the age of effective recall, these excess weapon systems have often been modified for use in alternative roles, offered for resale or have finally been scrapped.

Because of the very rapid increase in the IDF's mobilizeable order of battle between 1967 and 1979, it became financially impossible for it to maintain its order of battle after 1990 without either a disproportionate increase in the Israeli defense budget or the recycling of older equipment and the acceptance of reduced technological quality. Because of significant budget limits since the late 1980s, the IDF has consistently chosen quality over quantity and allowed the mobilizeable order of battle to constrict.

Based on the recent release of declassified US National Security Council minutes for the years 1973 to 1980, the declassification of Israel's post 1973 war commission minutes and the publication of the history of the IDF ordnance corps up to the mid-1980s, it is now possible to very accurately define the order of battle and material holdings of the IDF up to about 1977. Thereafter, the availability of open source data of US arms exports to Israel, classified US documents released by Wikileaks, as well as data on the transfer to Israel of US excess defense articles since 1992, together with reasonable professional assessments of the long-term impact of changes in the active Israeli force structure, as well as Israeli domestic military production, has allowed reasonable estimates of the more recent IDF's order of battle. There are two notable exceptions: first, the numbers and capabilities of "black" weapon systems believed to have been developed jointly by Israel and the US since 1992 and, second, the capabilities of still unpublicized weapon systems developed and deployed by Israel.

ARMORED CORPS

In 1949, the IDF had one understrength armored brigade with only two tank companies. The IDF could field about 30 tanks, perhaps 150 half-tracks and an assortment of armored cars of varying effectiveness.

By October 1956, the IDF's inventory of armored fighting vehicles had grown to some 460 tanks and 730 half-tracks. There were roughly 20 M-10s with 17 pounder guns; 180 AMX-13 light tanks; 25 M-50 newly produced updated M-4 Shermans with high velocity 75mm guns; 125 M-4s with 76mm guns; 85 M-4s with low velocity 75mm guns; and 25 M-4s with 105mm howitzers. The rapid delivery of AMX-13s and M-4 Shermans in 1955-56 resulted in critical shortness of trained tank crews as the one active conscript tank brigade could annually generate only a limited number of fully trained reserve tank crews. Therefore, the IDF's three armored brigades and two independent tank battalions could actually deploy only about 280 of these 460 tanks.⁶

By 1967, the IDF's inventory of armored fighting vehicles had grown to some 1,300 tanks and 2,700 half-tracks. Its order of battle apparently included seven tank and four armored infantry brigades, plus five independent tank battalions, which cumulatively deployed about 1,100 tanks. The tank inventory included 250 M-48A1; M-48A2C and M-48A5 Pattons; 385 Centurions; 180 AMX-13; and 515 M-4 Shermans, comprising about 175 Mk 51s with 105mm 51 caliber guns, 225 Mk 50 with 75mm 62 caliber guns and 115 M-4A3E8 with 76mm guns. Almost all of the Shermans had received new diesel engines and communication sets. About 30% of the IDF's Pattons and Centurions could not be deployed in 1967, lacking trained crews or caught in depots undergoing major reconstruction and upgrade. Less than 3% of the Centurions and Pattons had been fully upgraded with either L-7 or M-68 105mm guns and diesel engines. The organization of armored brigades had been significantly modified, with each brigade comprising two tank battalions and one armored infantry battalion; while each of the newly formed armored infantry brigades included one tank and two armored infantry battalions. All tank and armored infantry battalions had organic fire support provided by self-propelled 81mm mortars mounted on half-tracks. The armored infantry battalions incorporated half-tracks mounting 20mm cannon, as well as 90mm anti-

tank guns. Tank companies had generally been reduced to 14 tanks (based on three platoons, each with four tanks), and no longer included an organic armored infantry platoon.⁷

By 1973, the IDF's inventory had grown to some 2,150 tanks: 600 M-113/M-577/M-548s; over 3,800 half-tracks; and 250 captured Soviet BTR-40, 50 and 152 APCs. IDF depots had been able to completely remanufacture about 1,100 Pattons and Centurions since the 1967 war with diesel engines and 105mm guns at a steady rate of 250 MBTs per year. Its order of battle now included six armored divisions, one independent tank brigade and at least three independent tank battalions. Each armored division had a uniformly planned table of organization comprising two tank brigades, one armored infantry brigade, and a combined-arms armored reconnaissance battalion, plus an artillery brigade and an organic support brigade. All but two of the tank brigades now had three tank battalions, each comprised of three tank companies and one armored infantry company. The active 7th tank brigade had two tank- and one armored infantry battalions, while the 274th reserve tank brigade had four tank battalions. The armored infantry brigades still had one tank battalion with four tank companies, plus two armored infantry battalions. During the post-1967 reorganization of the Israeli Armored Corps, its tank battalions had lost their organic self-propelled 81mm mortars, and many of its armored infantry battalions had lost their organic half-tracks with 20mm cannon and 90mm anti-tank guns. The planned ratio of tank-to-armored infantry companies within each division was 24:14.⁸

Even after its recovery from the strategic surprise attained by the Egyptian-Syrian attack, at no point during the October 1973 did the IDF manage to employ over half of its tank inventory on both fronts combined. By the end of the fighting on October 24, the Armored Corps had been decimated to some 1,100 serviceable tanks with most of its tank brigades and battalions grossly undersized due to war losses. Immediately after the war, the number of serviceable MBTs was quickly restored through the repair of combat damaged tanks, the use of captured T-54, T-55 and T-62 tanks, and the receipt of limited US Patton tank deliveries. Realizing that the removal of self-propelled 81mm mortars from its tank battalions had been a grave error, the IDF reintroduced this weapon system on existing half-tracks, followed by the postwar acquisition of 600 M-125A1s.⁹

Interestingly enough, the IDF divisions in 1973, as originally organized, were far less tank heavy than generally perceived. Moreover, in contravention of the common attribution of its initial heavy tank losses to the failure to deploy combined arms units, after the war the IDF reduced the ratio of infantry to tanks within its divisions and instead added a third tank brigade to each armored division. Likewise, since the combined arms divisional reconnaissance battalions proved to be a tactical failure, they were reorganized into light scout units. The existing armored infantry brigades became independent units that could be allocated to divisions, corps or fronts as directed by the general staff. The IDF's reaction to the widespread Arab use of ATGMs and RPGs was to generate a significant increase in the artillery, mortars and tank-mounted machine guns organic to each division, having concluded that, in open desert terrain, anti-tank weapons were best addressed by suppressive firepower, not armored infantry mounted on light APCs that were vulnerable to enemy artillery and firepower.¹⁰

At the end of 1977, the IDF inventory included about 3,800 tanks; 2,500 M-113/M-577/M-548s and derivative APCs; over 3,000 half-tracks; and 400 captured Russian APCs. Its order of battle had increased to nine tank divisions (three active at partial strength plus six reserve), plus one independent tank brigade. There apparently were 28 tank brigades (12 with Pattons, 12 with Centurion Shots, three with Tiran 4/5s and one with Tiran 6s) plus nine armored infantry brigades and at least three independent tank battalions. Amazingly, in just four years, the IDF had fully replaced its heavy war losses and increased the order of battle of the Armored Corps from 19 to 37 brigades. Three new Corps level headquarters had been generated after the 1973 war to command this expanded order of battle.¹¹

In the decade following 1977, the IDF is believed to have procured an additional 150 M-48A5, 280 M-60A1 (passive) and 330 M-60A3 (thermal) Magach tanks and over 4,500 additional M-113/M-577/M-548 APCs from the US. It also received several hundred additional Centurions. Like many of the Centurions acquired by the IDF, these MBTs had reverted to US ownership after their replacement in NATO militaries then sold to Israel at scrap prices. Starting in 1978, the IDF's inventory of MBTs was supplemented by the introduction of new production Israeli Merkava tanks, which were apparently produced at a steady rate of one brigade set per year.¹²

The additional armored vehicles received after 1977 were progressively used to replace the remaining M-50 and M-51 Shermans and many half-tracks, while simultaneously allowing a further steady increase in the Armored Corps order of battle. By 1979, the IDF's order of battle had increased to 11 tank divisions and 12 armored infantry brigades. The two newest reserve divisions were likely still being formed and, consequently, were under strength. In less than five years, the order of battle of the Armored Corps had increased from 19 to about 43 brigades and the number of serviceable MBTs had doubled from 2,150 to about 4,200.¹³

During the late 1970s and early 1980s, thousands of previously remanufactured IDF Shot and Magach (Patton) tanks were substantially improved, receiving supplementary reactive armor, automatic instantaneous Halon fire suppression systems, spaul liners, gun barrel thermal shrouds, smoke grenade launchers, externally mounted 60mm mortars, additional 12.7mm and 7.62mm machine guns and digital fire control systems incorporating laser range finders and second generation passive or FLIR gunner sights, along with main gun stabilization. The extent of this upgrading was reflected in the purchase of over 2,000 TARS optical relays for the gunners' image intensifying peri-telescope, used by the M-48A5 and the updated gunner's sight of the Shot D and 1,000 Honeywell thermal elbow sights used by the M-32 peri-telescope of M-60 and M-60A1 MBTs.¹⁴

It has been reported that, sometime after the 1982 Lebanon War, the IDF made a fundamental change to the organization of its infantry, with existing armored infantry brigades losing their organic tank battalion and gaining a third infantry battalion. This is assessed to have reflected several factors: the personnel of the Sherman tank battalions assigned to armored infantry brigades became overage; IDF tank divisions operating in mountainous and/or urban terrain required more dismountable infantry; and the significant increase in the number of active infantry brigades formed after the Lebanon war inevitably led to the annual generation of many more reserve infantry battalions. The newly reorganized mechanized infantry brigades apparently were no longer part of the Armored Corp's order of battle.¹⁵

By 1987, it is estimated that the IDF had a serviceable inventory of no less than 4,600 MBTs and 10,600 APCs, including 13 heavy armored divisions, three active at partial strength and 10 in reserve. These very large

and powerful armored divisions generally included three organic tank brigades, an artillery brigade with five medium artillery battalions, and a support brigade with ordnance, transport, medical, and communications battalions, plus light reconnaissance, anti-tank, armored engineer, and anti-aircraft battalions. There would be 27 tank, nine armored infantry, six reconnaissance and three combat engineer maneuver companies in each full-strength heavy division. The IDF's heavy armored divisions could each field about 335 tanks, and about 700 other armored fighting vehicles, including an estimated 96 self-propelled 155mm howitzers and 120mm and 160mm heavy mortars, 81 self-propelled 81mm medium mortars, and 36 TOW armed tank destroyers. Armored or mechanized infantry brigades were often attached to these heavy armored divisions as required. Because each tank now mounted four machine guns and a 60mm mortar, and each infantry APC mounted three machine guns, plus at least one 60mm mortar per mechanized infantry platoon, IDF sub-units could generate far greater short to medium range suppressive fire capability than any other international unit. The IDF's estimated inventory in 1987 included about 2,350 Magachs; 1,300 Shots; 450 Tirans; 800-900 Merkava Mk Is and IIs; over 7,000 M-113 family AFVs; and, probably, at least 2,000 surviving half-tracks, many of which had been upgraded with diesel engines. Based on the planned 1973 war reserve allowance of 250 main gun rounds per MBT and the actual inventory of about 180 rounds per tank, in 1987 the IDF would have maintained an inventory of 900,000 to 1,250,000 105mm tank rounds in war reserve storage.¹⁶

From the mid-1970s to the early 1980s, the conscript-filled active force structure of the IDF Armored Corps included six operational brigades and one large training tank brigade, which could be mobilized for wartime use but was not used for day-to-day security operations. To reduce cost, a conscript-crewed operational tank brigade was deactivated in 1984-85 while another was deactivated in 1994-95. Based on this active force structure, the IDF should have annually generated tank crews adequate to create about eight new reserve tank battalions each year between 1976 and 1984, seven new reserve battalions per year between 1985 and 1995, and six new reserve battalions per year between 1996 and 2004.

In 1967-87, the personnel of about 21 reserve tank battalions had become overaged and were apparently deactivated. The IDF fielded about 50 tank

battalions in the October 1973 war. It very likely generated newly minted reserve tank crews that could have manned a maximum of about 110 reserve tank battalions between 1974 and 1988. Therefore, the IDF could have theoretically mobilized up to 160 tank battalions by 1988. However, this number was almost certainly reduced by wastage (illness, emigration, etc.) and the need to provide a margin of trained tank crews to ensure that all reserve units could be immediately mobilized without prior warning at near full-strength as well as to provide supplementary trained crews that could replace combat casualties. It should also be noted that there is evidence that active tank units were often under strength, which would have reduced the number of reserve tank crews being generated annually. By 1988, it is assessed that the IDF had adequate numbers of trained tank crews and serviceable MBTs to support an order of battle comprising the previously noted 13 heavy tank divisions deploying at least 36 tank brigades. This, then, represented the world's third largest armored corps.

By 2003, there likely still were adequate numbers of trained tank crews and serviceable MBTs to generate about 110 reserve tank battalions, assuming that enlisted reserve tank crews would be in service up to the age of 42; that there had been 10-15% wastage after entering reserve service because of unsuitability, illness and emigration; and that the IDF maintained a 10% margin of extra tank crews in order to insure that all mobilized reserve units could be brought up to full strength on short notice. This would be consistent with a total estimated mobilizeable force structure of 13 heavy tank divisions totaling some 36 tank brigades, the same order of battle estimated since the late 1980s.

Up to the late 1980s, IDF armored infantry had been mounted on light APCs, initially half-tracks and, later, M-113s. These light APCs were relatively lightly armored and were not suitable for mounted offensive operations against well prepared, fortified strongholds. Israeli M-113s had been provided with perforated high hardness standoff steel armor capable of defeating Soviet 14.5mm heavy machine gun rounds and providing limited standoff vs. RPG HEAT rounds. The standoff, plus the provision of internal Kevlar spaul shields, combined to reduce the after penetration lethality of HEAT impacts. Still, since the IDF did not consider its upgraded M-113s to be adequate for assault it developed a simple Kangaroo version of the Shot MBT chassis for assault use. This vehicle

had an open casemate, surrounded by reactive armor. Unfortunately, its embarked infantry could not easily or securely dismount. Therefore, the Achzaret, a passively armored heavy APC, which was based on the use of a re-engined, extensively modified T54/55 chassis, relatively quickly followed this initial vehicle. The Achzaret had a narrow clamshell rear ramp, which allowed its embarked infantry squad to securely and safely dismount under fire. The IDF's reported intent was to procure 1,000 of these heavy APCs – a number adequate to equip some of the armored infantry companies attached to the tank battalions of its tank brigades, and/or some of the mechanized infantry brigades. However, to reduce cost, this acquisition program was reportedly prematurely terminated in 1994. Consequently, only about 285 of these heavy APCs were reportedly produced, enough to mount only a small proportion of the IDF's mechanized infantry. Terminating the Achzaret program is assessed to have been a major error. However, it should be noted that during this period each active tank brigade had added an armored combat engineering battalion. These battalions were mounted on a heavily modified, passively armored, casemated Centurion Shot chassis, which is called the Puma. These armored engineering battalions considerably enhanced the ability of IDF tank brigades to penetrate through prepared Arab defenses protected by minefields. To some degree, the introduction of the Puma offset the reduced number of available heavy APCs. As time progressed, additional reserve armored engineering battalions mounted on the Puma were created and attached to many reserve tank brigades.

Starting in the mid-1980s, reserve tank brigades equipped with the Shot, the Magach 3, and the Tiran 4, 5 and 6 had been progressively deactivated, largely because their crews had reached the age of 42. These MBTs were not recycled for further use, though they were at least the technical equals of the vast bulk of Arab armor. However, some of these deactivated tanks were being steadily replaced in the reserve order of battle by new Merkava tanks rolling off the production line. In 1992, the last active tank battalion mounted on upgraded Shot Ds was reequipped with Merkavas.¹⁷

In 2003-2004, after the US occupation of Iraq, the IDF reportedly deactivated three reserve tank divisions that were then equipped with the Magach 6R (upgraded M-60A3), Magach 6B Gal (upgraded M-60A1) and Shot D tanks. At that time, the last conscript crewed active tank brigade equipped

with the Magach tank was also deactivated with many reservists assigned to these units subsequently reassigned to other reserve formations.¹⁸

After the 2006 Second Lebanon war, it was decided to increase the mobilizeable order of battle, primarily to recreate a significant strategic reserve maneuver force. At that time, in the near term, this could have been quickly accomplished by reactivating some recently disbanded reserve tank brigades, but a long-term solution required retraining conscript Merkava crews for future reserve duty on Magach tanks. Generating additional reserve tank crews annually was also to be accomplished by adding a fourth tank company to each of the remaining 12 active tank battalions. This would have cumulatively increased the number of reserve tank crews generated each year from four to over five battalions. Creating newly generated reserve crews trained to operate the Magach would have permitted the retention of upgraded Magach tanks in service until about 2030.¹⁹

Just several years later, a change in the Israeli political-military leadership resulted in a complete reversal of the post-2006 decisions, notably in the form of a major downsizing of the Armored Corps mobilizeable order of battle. Six more reserve tank brigades were disbanded, four equipped with the Magach 7, and two with upgraded Merkava Mk1s. This meant that, over one decade, the mobilizeable order of battle of the Armored Corps had been reduced from about 36 to 24 tank brigades. Moreover, the previous decision to increase the number of reserve tank crews generated each year was cancelled, and it was also announced that each active tank battalion would be downsized from three (or four) to only two active tank companies, while a newly conceived reconnaissance/targeting/120mm mortar company would be added to these battalions. This meant that the active battalions would have to add both a third reserve tank company and a reserve armored infantry company to reach full wartime strength. More importantly, because of the significant downsizing of the number of active tank companies the number of reserve tank crews generated annually in future years would be halved, from over 15 companies (assuming four tank companies for each active tank battalion) to less than eight companies per year. This decision meant that the IDF would be able to generate a maximum mobilizeable order of battle of about 16 tank brigades by 2030, all equipped with Merkava Mk 3 and 4 tanks.²⁰

The current IDF inventory of armored vehicles in active service, held in storage for use by reserve armored or infantry units, or maintained as a war reserve to replace combat losses, is estimated to include about 2,900 updated Merkava II, Merkava III and Merkava IV MBTs; 440 heavy Achzerit and Namer assault APCs; 700 Puma and newly generated Namer armored engineering vehicles; up to 200 casemated Shot based COIN heavy vehicles; 9,000 M-113/M-577/M-548 light armored fighting vehicles; 100 M-60/M-88 AVLBs and ARVs; and 150 heavy D-9 armored bulldozers. In addition, as many as 1,000 recently deactivated Magach 7, Magach 6B Gal and updated Merkava I MBTs still likely remain in storage. If required, many of these MBTs could be very rapidly reactivated. All older IDF MBTs and AFVs have been scrapped.²¹

The 2004 and 2014 reductions in the IDF's mobilizeable order of battle likely left it with only 24 tank brigades, adequate to generate eight large 1980s style heavy divisions. The table of organization of these divisions had been optimized for maneuver warfare in the open desert against conventional military units. However, since the current threat faced by the IDF is primarily urban combat against light infantry, it is believed to have significantly modified the organization of its tank divisions. In large part, this reflects the fact that the IDF generally appears to deploy combined arms battle groups, for combat, which are comprised of mechanized infantry supported by armored combat engineers and tanks. It is therefore estimated that the IDF can now mobilize 12 combined arms divisions, each currently incorporating two tank and two mechanized infantry brigades. These divisions are estimated to include 18 tank, 18 mechanized infantry, six armored infantry, seven reconnaissance, and six armored engineering companies.²²

Including deactivated armored vehicles awaiting disposal and self-propelled artillery chassis, over 15,000 potentially deployable armored fighting vehicles are located in Israel. This represents the largest current concentration of serviceable armored vehicles in the world. Historically, only the Soviet Union, Germany and the United States have deployed more armored divisions than Israel.

PARATROOPS AND INFANTRY

In 1949, the IDF could deploy 11 ill-equipped light infantry brigades.

In October 1956, the IDF had two active (one paratroop and one infantry) brigades plus 11 reserve infantry brigades. There were an additional 16 reserve infantry battalions available for static territorial defense. Armored Corps infantry units included three armored infantry battalions mounted on half-tracks and three truck-mounted motorized infantry battalions, plus an armored infantry platoon organic to each tank company.²³

Israeli infantry and paratroops at the time were primarily equipped with Mauser 98k bolt-action rifles, 9mm Uzi submachine guns and FN D automatic rifles, plus rifle grenades, bazookas and 52mm mortars. Crew-served weapons included MG-34 and Besa machine guns and 81mm mortars. Israeli infantry brigades generally had three infantry battalions, a reconnaissance company, an anti-tank battalion employing six pounder (57mm) towed guns, and a 120mm towed mortar battalion, each with 12 tubes. Most of the infantry brigades had limited numbers of organic half-track or cross-country capable trucks. The one elite paratroop brigade included a mix of two active and one reserve battalions.²⁴

By 1967, the IDF's infantry order of battle had added two additional reserve paratroop brigades, but the number of infantry brigades had been reduced from 12 to 7. This was offset by the fact that the Armored Corps now fielded 15 half-track mounted armored infantry battalions, in lieu of its previous six battalions, half of which were motorized. The additional nine reserve armored infantry battalions formed in 1966-67 absorbed most of the infantry reserves generated during those years. Many Israeli infantry squads had been reequipped with FN automatic and semi-automatic rifles. MAG light machine guns and M1919 machine guns modified to fire 7.62mm rounds, had largely replaced the MG-34 and Besa machine guns. As before, crew-served weapons included bazookas and both 52mm and 81mm mortars. Infantry and paratroop battalions now had organic anti-tank batteries equipped with jeep mounted 106mm recoilless rifles. Armored infantry battalions included half-tracks mounting 20mm automatic cannon at the platoon level, as well as half-track mounted 90mm smooth bore anti-tank guns (which fired fin-stabilized HEAT rounds), at the battalion level.²⁵

The IDF's mobilizeable infantry and paratroop order of battle had not significantly changed between 1967 and 1973, likely comprising three paratroop brigades and eight infantry brigades, of which probably two were considered first line. Moreover, during the October 1973 war the infantry and paratroop units largely used the same small arms and crew-served weapons they had used in 1967. Israeli FN semi-automatic rifles and Uzi submachine guns proved far less effective than the Kalishnikovs used by the Arab armies while the RPG-7 had three times the effective range of Israeli bazookas.²⁶

After the painful experience of the 1973 war, the IDF quickly improved its infantry firepower. Modern 5.56mm M-16A1 selective fire rifles were acquired, followed by the mass production of the Galil semi-automatic rifle. These replaced 7.62mm rifles and 9mm submachine guns in infantry squads. LAW rockets and captured RPG-7 launchers replaced the shorter range and heavier bazooka. More flexible 40mm grenade launchers progressively replaced rifle grenades. Recoilless rifles and anti-tank guns were replaced by anti-tank guided missiles, with the IDF ultimately acquiring about 500 TOW and 1,000 Dragon launchers and over 20,000 anti-tank guided missiles.²⁷

By the end of 1977, the number of armored infantry companies in the Armored Corps order of battle had again doubled to about 140. Other than the creation of a fourth reserve paratroop brigade, there could be no further change in the paratroop and infantry order of battle. The organic armored infantry companies of newly formed reserve tank battalions, plus six additional reserve armored infantry battalions, once again absorbing all the infantry reserves generated since 1973.²⁸

The 1982 Lebanon war exposed the IDF's need to increase the number of high-quality infantry brigades capable of straight-leg operations within its order of battle. In 1982-83 two new conscript-filled infantry brigades were activated - Nahal (in 1982) and Givati (in 1983), and by the late 1980s the IDF could likely mobilize 13-15 mechanized infantry brigades, five paratroop brigades and 6-8 territorial defense infantry brigades, plus about 108 companies of armored infantry that were organic to the Armored Corps tank battalions. The growth in the number of mechanized infantry brigades, each with three APC-mounted mechanized infantry battalions, had been

made feasible by the disbanding of the armored infantry brigades plus the creation of two new active infantry brigades, which led to increased numbers of reserve infantry battalions being generated annually after 1985. About half of the mechanized infantry was now likely considered high quality and capable of straight-leg offensive assault operations. In the following years, six new conscript-filled light infantry battalions were also progressively generated, used in the West Bank, Gaza and border security patrols before being grouped for administrative purposes in the oversized Kfir brigade. Recently, three diverse special force battalions have been grouped together in a newly formed commando brigade. It is assessed that for nearly two decades the IDF has annually generated trained personnel to form 6-7 new battalions of reserve infantry.²⁹

The changes in the conscript active force structure have considerably increased the current mobilizeable paratroop and infantry force structure. It is estimated that the IDF can now deploy one elite multi-roll paratroop division with one active and two reserve paratroop brigades, plus the newly formed commando brigade, as well as two independent reserve paratroop brigades, one assigned to the northern command and another to the southern command. Israeli infantry forces likely now include 12 high-quality infantry brigades (capable of acting in both the straight-leg and mechanized roles), four conscript and eight reserve, twelve reserve mechanized infantry brigades and ten reserve territorial defense light infantry brigades, plus 72 armored infantry companies, totaling the equivalent of about 450 commando, mechanized, paratroop, assault and territorial defense infantry companies. The reserve territorial defense light infantry brigades are likely assigned to four territorial defense divisions which are responsible for border defense as well as internal security on the West Bank.³⁰

Each mechanized infantry or paratroop brigade likely currently includes three infantry battalions and a support battalion with reconnaissance, engineer and anti-tank companies. All infantry battalions are being progressively equipped with power operated, computer controlled, 120mm mortars and the very capable NLOS Gill ATGM system.

ARTILLERY AND ANTI-TANK

In 1949, the IDF had less than 175 obsolete light howitzers, medium mortars, anti-aircraft and anti-tank guns.

By 1956, the IDF had acquired about 160 British 25 pounder (88mm) and 34 M-50 French 155mm towed howitzers, plus 24 105mm self-propelled howitzers on AMX-13 chassis. It could also field about 300 120mm towed mortars, and its inventory included about 300 6 pounder (57mm) and 17 pounder (77mm) towed British anti-tank guns operated by the Artillery Corps. As previously noted, IDF infantry brigades generally had an organic 120mm mortar battalion and an anti-tank gun battalion, each with three batteries of four tubes. Howitzer battalions or batteries were allocated to brigades, divisions or fronts under the central control of the General Staff.³¹

By 1967, these existing weapons had been supplemented by about 40 additional 25 pounder howitzers captured in 1956, 36 self-propelled obsolescent M-7 105mm howitzers provided by West Germany, about 30 additional M-50 French 155mm howitzers (some of which were now mounted on a heavily modified Sherman chassis), and perhaps 60 Israeli-produced Finnish Tampella 160mm towed heavy mortars. A significant portion of their 120mm Soltam mortars were now self-propelled and mounted on modified half-tracks.³²

The IDF's 6-pounder anti-tank guns were in the process of being converted to 90mm smooth bore barrels firing fin-stabilized HEAT rounds. These guns were also being mounted on modified half-tracks. Jeep mounted 106mm recoilless rifles, manufactured in Israel, which were organic to infantry battalions, had also supplemented the available inventory of anti-tank guns.

In 1973, the IDF is known to have fielded three battalions of M-107A1 self-propelled 175mm guns and one battalion of self-propelled 203mm M-110A1 howitzers (converted from 175mm during the war). This was the first time the IDF fielded heavy artillery. There were 14 battalions of self-propelled medium 155mm howitzers (9 M-50, 3 L-33 and 2 M-109) and seven battalions of self-propelled M-68 160mm mortars. There were also three battalions of M-7 105mm self-propelled howitzers and

12 battalions of self-propelled 120mm mortars. In addition to this self-propelled artillery, there were three battalions of towed M-50 155mm howitzers, two battalions of captured towed M-46 130mm guns (which had been mounted on new Soltam chassis), perhaps four battalions of captured towed D-30 and M-38 122mm howitzers, and up to 12 battalions of towed 120mm mortars. One reduced battery of lightweight M-102 105mm towed howitzers was available for use by helicopter inserted special forces. There was one multiple rocket launcher battalion equipped with captured 12 tube 240mm launchers mounted on 6x6 trucks, and one newly formed, partial strength MRL battalion equipped with four rail 290mm launchers mounted on de-turreted M-50 Sherman hulls.³³

In 1973, available Israeli artillery support for its brigades and divisions proved wholly inadequate. There simply were too few tubes, and the daily consumption of rounds per tube was far higher than the IDF had anticipated. Consequently, its ammunition war reserves, based on a planned inventory of 800 rounds per medium caliber tube, proved far too low. During the war, the IDF employed all of the available 175mm and most available 155mm and 130mm rounds. One quickly learned lesson was the need to increase both the number of available tubes for each division, while also significantly increasing the number of war reserve rounds available for each tube.³⁴

In 1974-77 the IDF was able to significantly increase its artillery order of battle, while simultaneously attempting to expand its war reserve ammunition holdings, initially, most likely to 1,200 rounds per medium caliber tube. In just four years, the IDF added about 450 M-107A1, M-109A1 and M-110A1 artillery pieces provided by the US, plus an estimated 72 additional L-33 self-propelled Soltam 155mm howitzers and 72 additional self-propelled M-68 Soltam 160mm mortars, both mounted on modified Sherman chassis. In addition, its towed artillery holdings were increased by the addition of 48 M-114 155mm howitzers, an additional 36 captured Soviet M-46 130mm guns and up to an additional 90 captured Soviet 122mm D-30 and M-38 howitzers. During this period, the IDF also added as many as 200 M-106A1 120mm self-propelled mortars operated by the Artillery Corps and over 600 M-125A1 81mm self-propelled mortars operated by the Armor and/or Infantry Corps. The 81mm mortars had, again, been made organic to all tank battalions.

These increases could not be matched by a corresponding growth of the war reserve ammunition per tube. The magnitude of this increase in artillery firepower is illustrated by the fact that in October 1973 the IDF deployed about 180 155mm howitzers and held about 150,000 155mm rounds in its war reserves. By the end of 1975, only two years later, it could deploy about 450 155mm howitzers and held at least 390,000 rounds of ammunition in storage; an increase of about 250%.³⁵

In 1973, the artillery brigades of each of the six tank divisions generally deployed two or three battalions of 155mm self-propelled howitzers, a battalion of self-propelled 160 mm mortars and two battalions of self-propelled 120mm mortars. By 1977, there were nine divisional artillery brigades, most with four battalions of 33 or 39 caliber self-propelled 155mm howitzers and one battalion of self-propelled 160mm mortars. This significantly increased the weight of shells that could be fired in a salvo, as well as the range of its 155mm howitzers. Moreover, many maneuver brigades now likely, again, had an organic battalion of 120mm self-propelled mortars for direct support and every tank battalion was, again, supported by organic self-propelled 81mm mortars.³⁶

It is believed that after the 1973 war the general staff decided to maintain war reserve spares and ammunition for 28 days of intense combat, while simultaneously increasing the number of planned rounds fired per day well above the 60 per medium tube a day apparently assumed in its pre-1973 calculations. In the late 1970s, Israel vastly increased its ability to manufacture artillery ammunition, increasing the numbers produced per day from a mere 250 155mm shells in 1973 to at least 3,000 major caliber artillery shells per day. By the mid-1980s, the Israeli ammunition war reserves probably included as many as three million shells for its 122mm-203mm artillery and 160mm mortar tubes, plus at least 600,000 shells for its 120mm mortars.³⁷

By the mid-1980s, the IDF could likely field about 180 heavy self-propelled (175mm/203mm) tubes; 1,000 self-propelled medium tubes (155mm/160 mm); at least 500 self-propelled or towed 120mm mortars, plus over 400 towed 155mm howitzers (including 39 caliber Soltam M-71 tubes originally produced for export to Iran); 130mm guns, and 122mm howitzers. Its maneuver battalions could likely deploy about

2,000 81mm mortars, many of which were self-propelled, while every MBT and many APCs mounted over 5,000 60mm mortars.³⁸

By this time, the organization of many Israeli medium artillery battalions had apparently been modified to reflect an increase from twelve to eighteen tubes. At its peak strength, the artillery corps likely could field about 65 self-propelled medium (155/160mm) battalions; 15 self-propelled heavy battalions (still with 12 175/203mm tubes per battalion); at least 24 battalions of towed 122, 130 and 155mm artillery, three rocket/missile battalions (Lance, 290mm, and 240mm); and at least 50 battalions of self-propelled or towed 120mm mortars. Still, by US standards, each of the three IDF multi-division Armored Corps lacked multiple supplementary artillery brigades above those organic to its divisions, and Israeli divisions did not have organic heavy artillery battalions. By comparison to US practices, the Israeli General Staff preferred to allocate its heavy artillery battalions and towed general support artillery brigades to Front or Corps, or even divisions, in accordance with their priorities, rather than parceling out these units in a uniform table of organization.³⁹

The IDF began to field leading edge long-range NLOS missile systems in 1986. They had developed two alternative missile systems, the Nimrod, which required laser terminal target illumination and the more flexible Tammuz electro-optically guided missile, controlled by data link. It exported the Nimrod but secretly deployed the Tammuz, which was mounted on the M-113 chassis (six tubes per vehicle), the M-48A5 chassis (12 tubes per vehicle) and light special force Land Rovers (four tubes per vehicle), which were employed by the IDF's special forces most likely because these narrow vehicles could be carried internally by CH-53 helicopters.⁴⁰

In the late 1980s, the General Staff began to downsize the artillery corps order of battle. First, the reserve crews of the roughly 400 Sherman-based self-propelled 155mm howitzers and 160mm heavy mortars became over-aged, as the General Staff decided that these still effective weapon systems would not be recycled for another operational tour of duty. By 1990, surplus Sherman-based self-propelled 155mm howitzers were being offered for sale by SIBAT. Sometime later, the procurement of new production MLRS launchers and the development of low CEP Accular trajectory-corrected rockets led to the progressive retirement of

the IDF's relatively large inventory of long-range 175mm guns. Reserve units using towed 155mm howitzers, 130mm guns and 122mm howitzers were also progressively deactivated as their personnel aged. This trend was reinforced by the IDF's ever-increasing emphasis on counter-insurgency operations in Gaza and the West Bank, where conventional artillery played an insignificant role.

To a limited degree, the order of battle reductions in tube artillery was offset by the increased deployment of long-range NLOS Tammuz missiles (replaced much later by Spike missiles), the availability of guided MLRS rockets, and the widespread deployment of 120mm mortars at the battalion versus brigade level. The introduction of state-of-the-art fire-control radars, digital fire-control computers, advanced cluster munitions, UAVs for targeting and fire correction, and a digital battle management system had also significantly increased the accuracy and lethality of the remaining tube artillery, while simultaneously reducing its response time. More recently, the artillery corps has begun to deploy GPS-guided fuses for its 155mm artillery and 120mm mortar shells. It has been reported that the conversion of artillery to precision fire assets will lead to the number of tubes in IDF artillery battalions being reduced from 18 back to 12.

Many Israeli military officers believe that the IDF has cut far too deeply into its tube artillery order of battle. Available data suggests that active divisional artillery brigades now have only two battalions of self-propelled 155mm artillery (with 18 or only 12 tubes per battalion) plus one battalion of MLRS launchers and one battalion of NLOS missile launchers. These individuals believe that there remains a military need for sustained suppressive, harassment and interdiction fire that only massed long-range tube artillery can cost effectively generate. Only 24-36 conventional artillery tubes per division simply cannot provide this. It is assessed that these naysayers are correct.

In the 1990s, the IDF was offered 600 M-109A1 self-propelled howitzers under the US excess defense article program at no cost except transportation. These vehicles could have been rehabilitated and, if necessary upgraded, in Israeli military depots at a relatively low cost. The IDF rejected this offer primarily because it was unwilling to invest in rehabilitating and upgrading these vehicles and acquiring additional

ammunition war reserves. In retrospect, this rejection is believed to have been a very significant mistake.⁴¹

It is estimated that the IDF has a current inventory of 64 MLRS launchers, each equipped to fire either 12 extended range 220mm course-corrected Accular rockets employing cluster warheads; 18 newly developed Lance GPS-guided 175mm rockets with unitary warheads; 12 220mm GMLRS guided rockets with a range of 72 kms; and very likely, four very long-range guided missiles with large cluster or unitary warheads. The IDF is now in the process of introducing an additional 165 MLRS launchers into service, recently acquired from the US under the defense excess articles program. This could enable the IDF to meet its objective of providing an MLRS battalion for all of its reserve divisions. Alternatively, the chassis of these vehicles could be modified for use as the platform for new Israeli produced, power operated, 52 caliber 155mm self-propelled howitzers. In addition to its 229 MLRS launchers, the IDF currently depends on an estimated serviceable inventory of about 600 updated M-109A5 155mm self-propelled howitzers, plus well over 500 120mm Caradom power operated or conventional mortars and an unknown number of Tammuz or Spike NLOS missile launchers.⁴²

There can be no doubt that the availability of MLRS-fired Accular and GPS-guided rockets and NLOS missiles have combined to provide Israeli divisions with vastly improved counter-battery capability. The impending widespread deployment of course-corrected 155mm artillery and 120mm mortar rounds will further increase the lethality of IDF artillery against identifiable point targets. These advanced weapons, combined with real-time targeting generated by UAVs and an extremely advanced digital battle management system, will provide Israeli divisions with the ability to lethally attack deep mobile enemy armored formations or point targets. But two battalions of 155mm howitzers, no matter how accurate, cannot provide the quantity of suppressive fire needed to shield Israeli assault battle groups against long-range enemy ATGM teams and/or enemy infantry equipped with shorter-range man-portable anti-tank launchers. It is assessed that the IDF needs more conventional artillery tubes, with at least one, and preferably two, additional 155mm artillery battalions added to each divisional artillery brigade, and at least five independent artillery tube brigades recreated for reinforcing fire (one for the two remaining Corps, plus one per front).⁴³

AIR DEFENSE

In 1949, the IDF could deploy only a handful of light anti-aircraft guns.

By October 1956, the IDF could still deploy only minimal ground-based air defenses, incorporated into the artillery corps: one battalion of 12 radar-directed 3.7-inch heavy AA guns, plus about 300 single barrel 20mm and 30mm manually controlled AA cannon.⁴⁴

To offset the delivery of Soviet TU-16 and IL-28 bombers to Egypt, Syria and Iraq, the US agreed to sell Israel five Hawk surface-to-air missile batteries in the early 1960s - the first air defense systems assigned to the IDF. During this period, West Germany also provided Israel with some 200 L-70 power operated 40mm AA cannon and up to 40 Super Fledermaus radar fire control systems. By June 1967, the Dimona nuclear reactor, each Israeli airfield, as well as their air control radar stations, were all reasonably well-defended by multiple batteries of 40 mm power-operated radar-directed and 30mm manually controlled AA cannon, plus the Hawk SAM batteries. By contrast, Israeli ground units had minimal air defenses beyond their organic 12.7mm and 7.62mm machine guns.⁴⁵

Following the 1967 war, all land-based air defense systems were transferred to the Israel Air Force (IAF), including some 300 captured Soviet 37mm and S-60 57mm AA guns and numerous ZSU-2 twin and the ZSU-4 quadruple 14.5mm gun mounts captured in large numbers. In order to provide air defenses for its forward ground units during the War of Attrition (1969-70), the IDF developed a low-cost transvestite – the TCM-20. This consisted of twin 20mm guns placed on an upgraded power-operated M55 mount, with several hundred of these mounted on modified half-track chassis. Additional Hawk batteries were procured. By 1973, the IAF could field 12 Hawk batteries, each with six launchers and had an inventory of 400 missiles. These ground-based air defense systems proved to be relatively successful during the 1973 war, generating a much higher rate of attrition on attacking Arab aircraft than the much denser and highly touted Soviet SAMs and radar-guided guns deployed against the IAF.⁴⁶

Following the 1973 war, the IDF received self-propelled Chapparel short-range SAM launchers, M-163A1 VADS, 20mm self-propelled AA guns with a radar fire control system, and Redeye man-portable surface-to-air missiles, plus additional Hawk SAM batteries. It also incorporated captured SA-7 MANPADs and additional captured Soviet 14.5mm, 23mm, 37mm, and 57mm AA guns into its order of battle.

At its peak strength in the mid 1980s, the IAF could likely deploy 24 Hawk batteries, each of which apparently equipped with acquisition and fire control radar systems and four triple launchers. Two of these Hawk batteries were mobile, with the radars, fire control systems and launchers all mounted on modified M-548 chassis. The numerous mutually supporting Hawk batteries provided nearly complete coverage for virtually all of Israeli airspace. It is estimated that Israel could also deploy about 40 Chapparel mobile fire units; 200 Redeye and SA-7 firing teams; 500 static AA cannon of 14.5 to 57mm; and 400 self-propelled TCM-20 and M-163A1 AA gun mounts. Each division now incorporated an attached air defense battalion with 20mm self-propelled guns and MANPAD launch teams. Each major air base, the Dimona complex and other vital installations were defended by air defense battalions equipped with the Chapparel fire units and radar directed static AA guns. The IAF also fielded small light infantry battalions to defend each of its major air bases against commando attacks.⁴⁷

The IAF had procured its first two area defense Patriot SAM batteries just before Operation Desert Storm (1991). Additional American and Dutch Patriot batteries were flown to supplement Israeli air defenses and were used to engage Iraqi Scud missiles fired during the war. Israeli test instrumentation was employed which fully documented each attempted intercept. As the Patriot proved to be operationally ineffective, the IAF made major software modifications to its batteries, correcting the deficiencies documented during Desert Storm. After the war, the IAF received five additional Patriot batteries from the US and Germany, all of which were progressively brought up to the latest Israeli standards. During this period, the IDF's inventory of M-163A1s was considerably increased by the addition of 72 vehicles transferred under the US Excess Defense Article Program. Israeli M-163A1s were subsequently upgraded with an advanced electro-optical auto-track/laser range-finder fire control

system, which replaced the radar, and the addition of a quadruple pod of Stinger missiles, which had also replaced the Redeyes employed earlier by MANPAD launch teams.

During the late 1980s and 1990s, the IDF's large inventory of static and mobile AA cannons was progressively deactivated as their reserve operators became over-age. The Chapparels lingered on until they were also deactivated after some three decades of service. The upgraded M-163A1s are no longer in active service, although they still likely remain operational with reserve units.⁴⁸

Over a decade ago, the Israeli military-industrial complex initiated the development of a conceptually unique three-tier level of air defense systems. These comprised the Arrow anti-ballistic missile system, the Magic Wand area air defense system designed primarily to defeat long-range rockets and cruise missiles, and the Iron Dome defense system designed to intercept short-range rockets. Each of these systems now provides world leading technological capability.

Today, the IDF is believed to deploy three Arrow II/III anti-ballistic missile batteries, one Magic Wand area defense battery, seven Patriot I/II SAM batteries, perhaps 16 surviving upgraded Hawk PIP III batteries, and 10-12 Iron Dome point defense missile batteries. Many of these batteries are reserve units. It is assessed that, after mobilization, Israel can deploy the world's densest and most capable multi-layer ground-based integrated air defense system, which provides unparalleled capability against medium-range ballistic missiles, aircraft, UAVs, and ground-to-ground rockets. Its ground forces continue to deploy Stinger man-portable SAMs and, very likely, updated M-163A1s.⁴⁹

The Israelis have begun to deploy the Arrow III missile, which will intercept longer-range ballistic missiles at higher altitudes and longer standoff ranges. Additional batteries of the spectacularly capable Magic Wand area air defense system will also be deployed in the near future. Three netted Magic Wand batteries, comprising strategically located long-range radars and remote missile launchers, will provide area coverage against long-range rockets and cruise missiles for all of Israel.

AIR FORCE

In 1949, the IAF had only a single fighter squadron that operated a mix of P-51 Mustangs, Spitfires and Jumbo powered Me-109s. There were only a handful of Israeli combat-qualified fighter pilots. This squadron was predominately dependent on foreign volunteers and mercenaries. Because of the very poor serviceability of the available combat aircraft, it is estimated that this squadron could only generate about 20 daily combat sorties.⁵⁰

By October 1956, the IAF had barely completed its transition from dependence on foreign aircrew to Israelis, but it had just begun the transition from flying obsolete WWII piston engine fighters to more modern jets. It could field a squadron of Mystere IVs (16 aircraft), a squadron of Ouragans (22 aircraft), a squadron of Meteors (15 aircraft), two squadrons of piston engine P-51 Mustangs (29 aircraft), two squadrons of Mosquitos (16 aircraft), a squadron of T-6 Harvards in the light attack role (17 aircraft), plus two B-17s used as heavy bombers. There were just 128 pilots available for these aircraft, of which only 47 had been trained to fly jets. Moreover, most of these Israeli jet combat pilots were novices, having accrued very limited numbers of jet flying hours. The IAF had also one transport squadron with 16 C-47s and 3 N2501 Noratlas.

The IAF aircrew of 1956, assessed to comprise enthusiastic and willing high quality amateurs, could likely generate no more than about 150 daily combat sorties. Their best aircraft, the Mystere IV, were not yet equipped with air-to-ground ordnance. Ammunition supplies were quantitatively limited and qualitatively mediocre. Radar coverage and ground-to-air and air-to-air communications were also generally limited in range and coverage.

The air war plan for the 1956 Sinai war was severely constrained by the overriding impact of Israeli collusion with France and Britain, as well as the conservatism of Israel's political and military leadership. The IAF was therefore precluded from preemptively attacking Egyptian air force bases. Ineptly planned and slowly executed British and French attacks on these air bases meant that the Egyptian air force was unconstrained during the first two days of the war; nevertheless, it proved to be utterly inept relative to the still-developing IAF.

Following the 1956 war, the Israeli political-military leadership came to understand how strategically vital the IAF had become. As a result, by June 1967 the force had fully matured deploying three Mirage IIICJ combat squadrons (65 aircraft); a Vautour squadron (19 aircraft); a Super Mystere squadron (39 aircraft); two Mystere IV squadrons (38 aircraft); two Ouragan squadrons (41 aircraft); and a Fouga squadron (45 aircraft). The lightly armed, short-range Fouga, which was not equipped with an ejection seat or any ballistic protection, could only be used in the short-range light attack role. The IAF could now generate an air crew-to-aircraft ratio of about 1.25:1.0 for its frontline combat aircraft and about 1.0:1.0 for its light attack Fougas. It could sustain the generation of over 500 first line combat sorties daily, supplemented by up to another 200 short-range Fouga sorties. If necessary, it had the ability to temporarily surge to 1,000 daily fast jet sorties during the first day of a preemptive attack.

The IAF also operated three helicopter squadrons - one heavy-lift, one transport and one light observation - equipped with about 12 SA-321K Super Frelon, 28 S-58, 12 OH-13D and five Alouette II helicopters. It had one heavy and two medium transport squadrons with about 11 Boeing C-97/KC-97, 25 Noratlas and 12 C-47s.

At the time, the IAF had a very limited attack capability at night and virtually none in bad weather. It had not yet deployed precision guided weapons. Its Mystere IV and Ouragan aircraft were elderly and had limited payload-carrying capability and range. The IAF had a limited electronic warfare capability as it could employ a handful of French SAM radar jamming pods and communications jamming systems. It could also deploy bulk chaff dropped by C-47 transports. It now had reasonable 3D radar coverage and air-to-ground voice communications and employed a variety of French and Israeli manufactured iron bombs with delay, contact and proximity fuses, air-to-ground rockets and napalm containers. It had also begun procurement of unique anti-runway bombs that Israel had jointly developed with France.

Between 1967 and 1973, the IAF was utterly transformed while simultaneously almost doubling in size. If in 1967 it was predominantly based on obsolescent French airplanes, within six years it had been largely reequipped with cutting edge American

F-4E Phantom and A-4E/H/N Skyhawk aircraft. These provided the IAF with the capability to deliver far heavier payloads per sortie, far more accurately, over much greater ranges than previously feasible. The typical war load of the F-4E Phantom in Israeli service was 10x750 lb. bombs and that of the A-4E, H, N Skyhawk 8x500 lb. bombs, as compared to only 2x250 or 500 lb. bombs for the French aircraft they generally replaced. All this transformation occurred while the IAF was constantly engaging in an ongoing war of attrition along the Suez Canal. During this period, IAF pilots flew thousands of successful ground attack sorties, while simultaneously achieving unparalleled jet-age air-to-air kill ratios.

Initially, during the 1967 war and the War of Attrition, isolated Egyptian and Syrian SAM-2 batteries were relatively easily attacked and destroyed. But later, Israeli attacks against large and dense SAM arrays with mutually supporting batteries, the most extensive yet deployed anywhere in combat, proved difficult and costly, generally resulting in the loss of about one combat aircraft for each destroyed SAM battery. The imposition of an unsupervised ceasefire allowed Egypt, with Soviet participation and support, to deploy its SAM arrays along the Suez Canal. This would subsequently create a huge tactical problem for the IAF at the onset of the 1973 war.

In October 1973, the IAF deployed four Mirage/Nesher squadrons with about 75 aircraft; four F-4E/RF-4E Phantom squadrons with about 115 aircraft; five operational A-4 Skyhawk squadrons with some 175 aircraft; and an upgraded Super Mystere squadron with 25 aircraft. The IAF had a total of some 390 fast jet combat aircraft, of which about 82% were serviceable at the outbreak of hostilities on October 6. It had about 400 combat rated fast-jet pilots plus 100 mostly newly generated weapon system operators for its twin seat Phantoms. Between 1967 and 1973, the generation of new pilots could not keep up with the rapid delivery of US aircraft. Consequently, only the Super Mystere squadron had a high air crew-to-aircraft ratio. Nevertheless, with proper warning, the fully mobilized IAF should have been able to sustain the generation of up to about 1,000 daily fast-jet combat sorties.

In addition, the IAF operated five helicopter squadrons – two heavy-lift, two transport and one light observation. These were equipped with 11 Super Frelon, 16 CH-53Cs, 50 UH-1Ds, and 25 OH-58s. It still had three transport squadrons, which operated 10 C-97/KC-97/EC-97s, 22 Noratlas and 12 C-47 transports. It had also recently added two new production C-130Es. During the war, the US provided 12 additional C-130Es and 12 CH-53Ds. After the war, the IAF ordered 10 additional new production C-130Hs, of which four were KC-130Hs, and 63 twin engine UH-1Ns to replace its UH-1Ds.⁵¹

On paper, the IAF was relatively well equipped to deal with the Egyptian and Syrian SAM batteries. Israeli Phantoms had ALQ 71, 87 or 101 ECM pods and all had passive warning systems. However, these electronic warfare systems had two operational deficiencies. First, their passive radar warning systems would not initially recognize SAM-6 CW radar signals, and second, they had not yet been fitted with self defense chaff and flare dispensers. Only about 25% of the IAF's Skyhawks were A-4Ns or updated A-4Hs with high thrust engines, passive warning systems, chaff/flare dispensers, and integrated digital navigation attack systems. It had standoff electronic warfare systems, which were either ground-based or mounted on helicopters or transport aircraft; but these were inadequate in number to simultaneously address both the Egyptian and Syrian SAM arrays. The IAF inventory included limited quantities of Shrike anti-radar missiles and first generation Walleye and HOBOT PGMs. All of this was offset by the inadequate training of IAF aircrews in SEAD tactics and the use of EW, which was primarily due to obsessive secrecy.⁵²

Unfortunately, the IAF's development of countermeasures that would have considerably improved its ability to defeat the Arab SAM arrays had not been completed. It had developed long-range 290mm surface-to-surface rockets with cluster warheads, intended to use against forward-deployed SAM batteries, and was developing a far more capable E/O guided standoff PGM than the Walleye. The Israeli weapon could be launched before lock on and had a more effective high explosive warhead than the linear shape charge used by the Walleye. Their most significant problem in 1973 was the lack of real time intelligence needed to provide the locations of mobile Arab SAM batteries. Consequently, it went to war technically and tactically unprepared to efficiently suppress dense enemy SAM arrays defended by

radar-guided AAA and SA-7s fired in mass. Moreover, because the IDF was caught by surprise, the IAF had to initiate air-to-ground attack missions before it was able to suppress the SAM threat. Strafing, so effectively used in 1967, was all but negated by SA-7s fired against IAF aircraft that were not yet fitted with self-defense decoy flares.⁵³

Caught by strategic surprise, the IAF was unable to successfully execute its preplanned, massive, multi-wave SAM suppression attacks and its overall combat management system proved grossly inadequate. It had inadequate staff, lacked anything approaching real time intelligence input, was poorly coordinated with the general staff and regional ground force commands, and had to employ slow teletype communications links to Israeli air bases. Some of these deficiencies were partially addressed as the war proceeded. Moreover, a largely static war, with the Arabs initially holding the initiative, deprived the IAF of doing what it could best do - interdiction of unprotected exposed convoys of densely packed soft vehicles during a war of maneuver. Due to relatively high initial losses, the IAF deliberately held back its squadrons during days 5-10 of the war in order to keep its serviceable inventory of fast-jets safely beyond a redline of 225 aircraft, the minimum number of serviceable aircraft assessed necessary to maintain air supremacy over Israel. Therefore, the average number of fast-jets combat sorties generated during the 1973 war was only about 600 per day, about two-thirds of which were attack sorties. The daily sortie generation was about 40% below prewar expectations and the effectiveness of attack sorties against static fortified positions was far lower than had been anticipated.

The IAF reacted very professionally to the painful hard-learned lessons of the 1973 war. It completely modified its command system and developed means for near real time intelligence. It installed fiber optic communication links between its HQ and its air bases that were necessary to rapidly plan and generate effective fast response ground attacks. The ability of air force intelligence to independently generate targets in near real time was vastly improved. All of the IAF's aircraft were equipped with more effective radar passive warning systems and chaff and flare decoy dispensers. It procured and developed a wide variety of air delivered precision and standoff weapons of US and Israeli manufacture, deploying air deliverable decoys and ground launched Standard ARM and two-stage long-range Shrike anti-

radar missiles, which could provide 24/7 suppression of enemy radars and SAMs along the FEBA. Every attack aircraft would soon be equipped with a state-of-the-art integrated navigation and attack system, and many were modified to deliver precision-guided weapons. By the end of the 1970s the IAF was likely one of the world's most tactically and technologically advanced military air forces.⁵⁴

In the late 1970s, the IAF received its first six AH-1G attack helicopters, initially used for operational evaluation. They were then returned to the US for the installation of TOW ATGM systems. Thirty Hughes 30D and 12 new production AH-1Ss were also ordered, all equipped with TOW ATGMs.

By the time of the 1982 Lebanon war, the IAF's order of battle had increased to one F-15A/B squadron with 25 aircraft; three F-16A/B squadrons with 72 aircraft; five F-4E/RF-4E Phantom squadrons with about 155 aircraft; five Kfir C1/C2 squadrons with about 130 aircraft; six A-4E/F/H/N operational squadrons with about 200 aircraft; and one reserve Mirage IIICJ squadron with 30 aircraft. It was estimated to have over 850 combat rated fast-jet pilots and, perhaps, 200 weapon system operators to man these aircraft, allowing it to sustain about 2,000 fast-jet daily combat sorties. However, it remained largely dependent on clear weather daylight operations. The Israelis had deployed unique missile launchers for ground-based Standard ARM and boosted range Shrike ARMs that were used to continuously suppress radars and SAM systems along the FEBA. Air launched Standard and Shrike ARMs were also employed. The IAF's a diverse inventory of thousands of precision-guided munitions allowed it to saturate enemy air defenses with both air and ground launched decoys.⁵⁵

The IAF also had seven helicopter squadrons - two attack, two heavy-lift, two transport and one light observation. Its fighting component included 48 30D and AH-1S attack helicopters, 40 CH-53 heavy-lift helicopters, 60 UH-1N transport, and 30 OH-58 observation/liaison helicopters. Its transport element included a squadron with 12 EC-707, C-707 and KC-707s, two squadrons with 24 C-130E/H and KC-130Hs, and a squadron with 12 C-47s.

The combined impact of Israeli improvements in command and control, intelligence, surveillance and reconnaissance, advanced electronics and precision guided weapon systems on the combat results of the 1982 Lebanon war was astounding. The dense Syrian SAM air defense system

in Lebanon was destroyed with minimal Israeli losses. The air-to-air kill ratio was 82-to-nothing. During the war, the IAF operated relatively leisurely by its standards, generating only about 500 daily fast-jet sorties, less than one-third of its full capability.⁵⁶

After 1982, the IAF did not rest on its laurels. Its leadership recognized that its fully digital fourth generation F-15s and F-16s were far more reliable and easier to maintain than its earlier aircraft. Moreover, evolving avionics, such as synthetic aperture radars and GPS navigation, combined with advanced precision-guided weapons, would soon permit the 24/7 operation of its advanced combat aircraft. To fully exploit these capabilities the IAF recognized that the most cost effective means of doing so was to increase the overall aircrew to aircraft ratio from the previous, but never achieved, objective of 1.5 to 1, to a ratio of about 2.5 to 1. This would enable future aircraft to conduct 24/7 operations and allow the IAF to generate an amazingly high sustained daily sortie rate. Its longstanding employment of active, emergency posting and reserve air crew within squadrons, irrespective of rank, allowed it to progressively and cost effectively increase the aircrew-to-aircraft ratio.⁵⁷

Recognizing that the capability of a tactical air force was predicated on both sortie quality and the number of sorties generated daily, any further growth in the IAF order of battle was curtailed. By the late 1980s it had reached peak strength of about 680 serviceable combat aircraft of which about 540 were deployed in 24 fast-jet squadrons, with an estimated total of about 1,250 active, emergency posting and reserve combat rated fast-jet pilots. These numbers were to progressively decline in the following years. By the late 1980s, the IAF could sustain some 3,000 fast-jet combat sorties per day and was believed to maintain war reserve munitions and spares for about 30 days of intense air warfare. It is assessed that the IAF had become the world's third most powerful air force.⁵⁸

In the 1980s, Israeli Aircraft Industries (IAI) began to develop the Lavi as a one-for-one substitute for the Kfir and A-4 for use in the close air support (CAS), battlefield air interdiction (BAI) and advanced training roles. The IAF initially planned to procure up to 300 Lavis during the 1990s, and the aircraft proved to be an extremely capable multi-role platform that could have likely been acquired at an acquisition cost well below that

of any comparable US or European combat aircraft. However, the IDF's ground forces had already deployed unique, world-leading, non-line of sight missiles that could be used to fulfill the CAS and BAI missions. Israeli combat experience in the 1973 war had been that CAS sorties resulted in excessively high aircraft loss rates. Therefore, in a dramatic transformation of roles and missions assignments, the Israeli General Staff, with the full support of the IAF leadership, transferred the CAS/BAI missions from the air force to ground based NLOS missile systems. This decision reduced the required number of Lavis from 300 to only 100. The reduction in the number of Lavis inevitably increased the total program cost per airframe, thus making the program no longer cost effective with its attendant suspension. Subsequently, in the 1990s the number of active Skyhawk and Kfir squadrons continued to be progressively reduced. Two batches, totaling 72 highly modified, new production F-16Cs and 54 F-16Ds (equipped as two seat multi-role combat aircraft, not trainers) were acquired to equip five squadrons. Two squadrons comprised of 55 F-4Es were also comprehensively upgraded, including the provision of leading edge APG-76 synthetic aperture radars (SAR), which enabled them to conduct all-weather strike operations.⁵⁹

Reserve Skyhawk and Kfir squadrons had been formed during the 1980s and 1990s. Their aircraft were systematically serviced, stored in environmentally protected cocoons, briefly reactivated every few months, test flown, serviced as required, and, again, environmentally stored. The reserve aircrew assigned to these squadrons flew weekly with active squadrons to remain current, while the reserve ground support personnel separately conducted annual training. These almost immediately mobilizeable reserve squadrons were progressively deactivated as the number of available reserve combat rated aircrew declined.

Following Operation Desert Storm, the IAF received 15 surplus USAF F-15A/Bs and 50 surplus F-16A/Bs. The six F-15Bs were immediately rehabilitated and upgraded for use as strike aircraft. The 36 F-16As were used to reequip the last active Kfir C7 squadron. The 14 additional F-16Bs were extensively used for operational conversion training. However, the elderly ex-USAF F-15As were only used in operational service for a short period of time and were thereafter generally cannibalized to provide spare parts.

In the late 1990s, one new squadron was formed, equipped with 25 new production F-15Is. A decade later, four squadrons were reequipped with 102 new production, twin seat, multi-role F-16Is. Like earlier Israeli F-16C/Ds, the F-16I is capable of operating at much higher maximum gross take off weights than USAF.

F-16s. Israeli F-16Is can now take off at a weight of 58,000 pounds using special techniques to prevent the overheating of the wheel of the forward landing gear, whereas USAF F-16s are limited to a MGTOW of only 42,300 pounds. Israeli F-16s can, therefore, employ both conformal fuselage fuel tanks and 600-gallon drop tanks. In wartime, they are designed to operate with boosted thrust engines; however, this significantly reduces the warranted time between overhaul of their engines. In 2004, in order to reduce cost, the two squadrons equipped with updated Phantom 2000s were prematurely deactivated; well before these outstanding strike aircraft had consumed their available service lives. These advanced Phantoms were initially stored for potential emergency wartime reactivation, but were ultimately broken up, as combat ready reserve F-4 aircrews became unavailable.

The IAF received 24 AH-64s from the US after Desert Storm. They subsequently ordered another 24 new production AH-64s to equip two full-strength attack helicopter squadrons. Some of the IAF's AH-1S/Qs were updated to employ long-range Tammuz ATGMs. Two squadrons of AH-1S/Qs continued to be maintained in service, based on the use of spare parts from 72 ex-US Army attack helicopters acquired via the US excess defense articles program. The IAF was, therefore, able to field four attack helicopter squadrons with nearly 100 serviceable airframes for many years.

The IAF continued to operate two squadrons of CH-53s, which were progressively upgraded with more powerful engines and strengthened transmissions, enabling operation at a MGTOW of 50,000 lbs., as well as being provided with advanced avionics and electronic warfare systems. The far more capable UH-60 – 24 received from US stocks plus 24 new production helicopters – replaced the IAF's UH-1Ns.⁶⁰

To reduce costs, the two AH-1 squadrons were progressively deactivated. This reflected the neutralization of any large-scale armored threat from Syria or Iraq. However, at the current time, it is probable that a reserve AH-1 squadron could still be rapidly reactivated.⁶¹

The IAF continues to operate the KC-707, with eight most likely remaining serviceable, as well as four heavily modified 707s, which have been used in the electronic warfare role. One squadron continues to operate 16 updated C-130E/H transports, while another squadron is slowly being equipped with seven new production C-130Js, which are being equipped with advanced avionics for low altitude covert missions. An electronic warfare squadron has been formed, comprising five Gulfstream 550s – two in the AWACs role and three with an advanced ground surveillance radar and ESM systems. It is estimated that several additional Gulfstream 550s will be acquired to replace the 707 in the electronic warfare role.

The IAF was the first air force to make widespread operational use of UAVs. In 1973, ground-launched Chukars were very successfully used as SAM decoys while ground and air launched Firebees were also used for reconnaissance. By 1982, these US systems had been joined in operational use by Israeli-developed ground launched mini UAVs, which provided tactical intelligence, and by the widespread use of disposable air launched decoys, which were used for SEAD. The IAF has since continuously upgraded its inventory of UAVs, which is now includes much larger, long-range versions with multi-mission payload capability. It is estimated that the IAF has also deployed both medium and large stealthy UAVs, which it has yet to reveal. It might have also covertly developed a very high speed UAV.⁶²

Israel has been able to develop and deploy a series of electro-optical and synthetic aperture radar reconnaissance satellites. These small satellites provide militarily useful resolution and now generate near real time surveillance coverage of surrounding enemy states. The combination of real time 24/7 input from satellites, UAVs, aircraft mounted surveillance pods, and imagery from electro-optically guided munitions, as well as unique Israeli ground-to-air and air-to-air data links, enable the Israeli air staff to maintain real time targeting and battle damage assessment.⁶³

The IAF is widely considered to be the most advanced theater-based tactical air force in the world. Almost every aircraft in its inventory can deliver precision-guided munitions. It has maintained the largest known inventory of PGMs outside the United States. Its 218 serviceable F-16C/D/Is can each sustain the generation of seven sorties a day out to a range

of about 800 kilometers. Because of their exceptionally high maximum gross takeoff weight and boosted engines they can conduct strike missions out to a range of about 2,000 kilometers without refueling. Each of its 82 serviceable F-15s can generate five sorties per day out to 800-kilometer range, and, as required, achieve unrefueled strike ranges of up to 2,000km. At ranges longer than 800km, it is estimated that the achievable daily sortie rate will progressively decline to about 3.3 per F-15 or F-16 a day.⁶⁴

The IAF currently generates the highest daily sortie rates in the world. Consequently, even after its order of battle has been reduced, it can currently sustain the generation of up to 2,000 daily F-15/16 fast-jet sorties out to a range of some 800 kilometers. Assuming that the IDF/SAF is able to maintain a peacetime serviceability rate of 0.85, it can generate over 1,500 F-15/16 daily sorties within 24 hours of activation. Due to the flight time required to execute each long-range sortie, the number of daily fast jet sorties progressively reduces to a maximum of about 960 daily sorties at a range of 2,000 kilometers, plus, perhaps, another 350 shorter-range sorties that could be simultaneously generated by reactivated F-16A/B and A-4N aircraft. It is estimated that the fully mobilized IAF is now capable of lethally delivering some 5,000 large (1,000 or 2,000 lb.) PGMs daily, a capability that no other regional air force in the world currently comes close to.⁶⁵

Before 2017, the IAF had not acquired any additional fast-jet aircraft for nearly a decade. However, during this time, it had updated all of its older F-15s, which are now capable of multirole operations, as well as updating the avionics of its F-16Cs and F-16Ds.

Today, the IAF has an active fast-jet order of battle of three F-15 squadrons with about 82 serviceable aircraft; four F-16I squadrons with 97 serviceable aircraft; two F-16D squadrons with 50 serviceable aircraft; three F-16C squadrons with about 71 aircraft; one F-35A squadron with only nine aircraft; and an advanced training squadron with 30 new Lavi Italian trainers. The IAF is believed to be able to quickly mobilize two large reserve squadrons, one equipped with about 40 A-4Ns and TA-4s and one equipped with about 40 F-16A/Bs. It is estimated to be able to mobilize some 900 combat qualified fast-jet pilots and 450 weapon system operators.⁶⁶

The IAF has ordered 50 F-35As. These are being slowly delivered between 2016 and 2022. The first squadron has been formed, but will not reach full strength until about 2019. In response to the P5+1 nuclear agreement with Iran, the IAF may ultimately acquire a third squadron of 25 F-35Bs.⁶⁷

Israel recently received nine F-15Ds via the US excess defense articles program. These trainers are being upgraded and rehabilitated in Israel for use as multi-role strike aircraft. Their acquisition would allow the IAF to combine them with its existing inventory of 16 comprehensively updated multi-role F-15B/Ds to form a second full-strength twin seat F-15 squadron. The best of the existing 31 single seat F-15A/Cs could then be grouped together in a single squadron. It is estimated that the IAF will very likely soon order 25 additional new production F-15Is to further increase its long-range strike capability.⁶⁸

One F-16C squadron will likely be deactivated when the first F-35A squadron reaches full strength, with its aircraft assigned to the two remaining F-16C squadrons. Israeli F-16As and F-16Bs have recently been withdrawn from active service and are being replaced by F-16C/Ds in the advanced training and adversary roles. Its F-15As also require near term replacement and will probably be deactivated if funding for new production F-15Is becomes available.⁶⁹

NAVY

In 1949, the Israeli navy consisted of ill-equipped corvettes, former USCG cutters and patrol boats.

In October 1956, the navy included two ex-British Z class destroyers and three ex-British River class frigates, which had been armed with obsolescent, single-purpose Italian 120mm guns for use in the surface warfare role.

In the early 1960s, the navy recognized the threat of the Skoryy class destroyers, and the missile-armed Komar and Osa class fast-attack craft (FAC), which had been supplied to Egypt by Moscow and which were equipped with Styx cruise missiles that could be used against both ships and shore targets. The Israelis, therefore, developed the first western missile-armed FACs. Designed together with the West German Lursen

shipyard, the FAC was a quadruple screw, steel-hulled version of the torpedo-armed, triple screw, wooden-hulled Jaguar torpedo boat. Named the SAAR class, the boat was equipped with the Gabriel 1 – a first-generation, beam-riding semi-active radar terminally guided surface-to-surface missile based on a previous missile developed by the IDF in the late 1950s. It was significantly out-ranged by the Soviet Styx missiles used by the Arab navies, but was difficult to defend against because of its sea-skimming attack profile.⁷⁰

The June 1967 war found the navy virtually unprepared. With its SAAR FACs were still under construction in France, it was equipped with the same two Z class destroyers, plus one Hunt class frigate captured from the Egyptian Navy in 1956. It also had a handful of French and Italian torpedo boats and one operational former British S class submarine. Consequently, for the navy, the 1967 war was a colossal failure. Soon after the end of hostilities, one of its two destroyers was attacked and sunk by Styx missiles with a heavy loss of life.

By 1973, the navy had been re-equipped with six SAAR 1/2, six SAAR 3 (with a 76 mm automatic gun) and two SAAR 4 FACs, almost all equipped with Gabriel 1 missiles. More importantly, these FACs had been outfitted with radar-absorbing materials to reduce their radar cross-sections across their frontal arc, long and short-range chaff rocket launchers, and passive and (in a few craft) active electronic warfare systems. The use of stealth, decoys and active countermeasures, combined with appropriate tactics, defeated every one of the 54 surface-to-surface missiles fired by the Egyptian and Syrian navies, whose FACs were destroyed by Gabriel missiles and 40mm/76mm gunfire, allowing the navy to dominate the eastern Mediterranean.⁷¹

The SAAR 4 had been designed for use in the Red Sea. It had longer range than previous Israeli FACs, and its longer hull would allow it to achieve higher speeds in the characteristic swells experienced in the Red Sea. But the October 1973 war occurred before Israel was able to deploy this vessel around Africa to Eilat. Nevertheless, Israeli naval commandos mounted on high-speed small craft were able to achieve naval superiority in the Gulf of Suez between Egypt and the Sinai Peninsula. The navy was prepared to launch a major amphibious assault on Egypt using eight

medium landing craft. Shuttling the short distance between Sinai and the Egyptian coast, the navy could have transferred the combat units of nearly a full armored division within 24 hours. This would have totally outflanked existing Egyptian defensive positions and the bulk of the SAM batteries deployed along the Suez Canal. It is assessed that even a small Israeli armored division, supported by the IAF in a region largely devoid of SAMs, could have rapidly and decisively outmaneuvered slow moving Egyptian strategic reserve units. However, the IDF general staff did not opt to execute this option. In retrospect, this is judged to have been a major operational error.⁷²

By the 1980s, the navy could field 24 FACs and three modern small diesel-electric submarines, plus numerous patrol boats and relatively large and capable naval special forces. It also contracted the Netherlands to develop a conceptual design for an advanced, stealthy, heavily armed, multi-roll corvette. This was subsequently designed in detail and constructed in the US without any USN participation in the project. The displacement of the Dutch concept design on which the SAAR 5 was based had been significantly underestimated. Therefore, as it grew heavier, its speed was reduced well below the initial Israeli objective. The cost of the SAAR 5 also grew far beyond Israeli expectations. Consequently, the number of Corvettes to be procured was progressively cut from eight to only three. To further reduce costs, the SAAR 5s were never fully outfitted in Israel with their planned number of fire control radars or weapons. Only one of three planned radar fire control systems was mounted and the number of Barak VLS cells was cut from 64 to 32. Deployment of a surface-to-surface version of the Barak missile was also cancelled. The original concept design mounted eight Gabriel 2 canister launchers in addition to eight Harpoon canister launchers. The Gabriels were never operationally mounted.⁷³

The SAAR 2, 3 and 4 FACs were progressively retired as their hulls reached the end of their service life. Eight new production SAAR 4.5 hulls entered service, which, in part, employed equipment cannibalized from the older FACs. These had slightly lengthened hulls and provisions for 32 Barak VLS cells aft. Like the SAAR 5, in order to save funds, these craft only were outfitted with one of two planned radar fire control systems.

Following Operation Desert Storm, Israel was able to upgrade its submarine force by procuring three very advanced attack diesel-electric submarines from Germany. These submarines were provided at a reduced subsidized price in order to induce Israel to suppress information on German industrial participation in Iraqi WMD projects. The submarines were modified to incorporate 10 bow torpedo tubes, four of which were 650mm (25.6 inches) in diameter, rather than the normal 21 inches. These large diameter torpedo tubes were almost certainly provided to enable the submarines to launch an Israeli developed nuclear-armed cruise missile. As far as known, these submarines could carry six additional reloads, giving each a maximum load of only 10 cruise missiles.

Israel is now in the midst of receiving three additional submarines from Germany. These are much larger than their predecessors, both longer and larger in diameter. They will incorporate an air-independent auxiliary propulsion system and, therefore, will have far greater endurance. Their design has, very likely, permitted the stowage of a larger number of reload cruise missiles, giving each a maximum load of perhaps 16 cruise missiles.⁷⁴

Israel is in the process of increasing its number of trained submarine crews and reportedly plans to have 10 crews for its six submarines. This will allow three or four submarines to be operated continuously at sea. Israel is currently negotiating the acquisition of three new, even larger, advanced submarines from Germany, for delivery in about 12 years.⁷⁵

The navy has recently ordered four small diesel powered frigates, which will again be constructed in Germany at discounted prices. These very heavily armed, limited speed, multi-purpose frigates will be primarily employed to defend Israel's offshore gas facilities. The best information available suggests that they will be equipped with advanced ASEA-phased array radars, 32 Barak 8 VLS cells, 40 Iron Dome VLS cells, 1 76mm and 2 Typhoon 25mm gun mounts, 8 ASCMs, 8 canister launched cruise missiles, 2 Mk 32 anti-submarine torpedo tubes, and a hangar and a helicopter landing deck sized for the SH-60F.⁷⁶

The navy is also in the process of upgrading its existing SAAR 4.5 and SAAR 5 combatants with AESA-phased array radars and the Barak 8 surface-to-air missile, which will provide limited area air defense coverage.

DISCUSSION

Between 1948 and 1977, the IDF grew from 90,000 personnel and 12 brigades to 700,000 personnel and 44 maneuver brigades. Initially, it fielded only 20 obsolete tanks; thirty years later, it could field 3,800 tanks, most of which were state-of-the-art. During the same period, the IAF grew from a single ill-equipped fighter squadron to 20 fighter-attack squadrons armed with cutting-edge combat aircraft. The number of combat sorties the IAF could sustain daily grew from a mere 20 to 1,200. The navy grew from virtually nothing to the dominant force in the eastern Mediterranean with 24 very capable fast attack craft. Since 1977, the IDF continued to grow and modernize. However, in 2003, and again in 2014, the IDF's mobilizeable order of battle was significantly reduced.

Today, Israel stands out as the dominant military power in the Middle East. It has been able to accomplish this while reducing the burden of defense expenditure on its gross national product from a peak of 24% in the post-1973 war years to about 6% today.

Israel is estimated to be able to quickly mobilize some 740,000 personnel, well below its prior peak strength of about 930,000. Its ground forces are estimated to include 64 maneuver brigades organized into 17 divisions that are equipped with over 14,000 armored fighting vehicles. The Israeli Air Force currently deploys about 300 exceedingly advanced F-15 and F-16 combat aircraft, and it is currently receiving new production F-35A aircraft. It can generate the world's highest daily sortie rate because of its uniquely high aircrew-to-aircraft ratio – some 1,600-1,850 sustained daily F-15 and F-16 combat sorties. The IAF has an exceedingly advanced and capable C4ISR system and maintains the world's second largest inventory of PGMs. Israel currently deploys the world's densest and most capable air defense system, which can intercept long-range ballistic missiles, cruise missiles, short-range missiles and rockets, aircraft and UAVs. It has a small but very capable coastal navy that is equipped with advanced corvettes, fast attack craft, attack submarines and very advanced small craft. It has the world's second most effective space-based surveillance capability providing near-real-time coverage of its theater of operations. It fields IRBMs, land, and sea-based cruise missiles, air and ground-launched ballistic missiles, air-delivered bombs

and artillery and rocket-delivered tactical warheads. It also has an aerosol chemical weapon delivery capability as well as an active biological warfare program. Israel has an exceptional civil defense system. Finally, Israel is a world leader in cyber warfare.

Ground Forces

The IDF has transitioned from a tank-heavy order of battle, conceived to fight and maneuver against conventional armies in the open desert to a far more balanced combined arms order of battle primarily optimized to battle non-state militias in urban areas.

Due to the changing nature of conflict over the past two decades, from all-out conventional wars to asymmetrical warfare where preventing or at least minimizing collateral damage is a priority, the current generation of senior Israeli officers lack the ruthlessness of previous Israeli combat leaders who could, and did, issue operational orders to attack and fight to the death. Moreover, many current senior general staff officers spent their formative years in relatively small special forces units, something that has impacted their thinking. Therefore, it is not surprising that the current general staff places low priority on decisive largescale engagement, heavy armor or tube artillery, having apparently forgotten that asymmetric warfare cuts in two directions, and that its militia enemies should not be able to dictate the style of combat or the rules of engagement.

The Israeli political-military leadership has similarly become politically correct, reluctant to accept casualties during training or even operational missions.

While the overall readiness of Israeli ground forces, primarily based on reserve units, has substantially declined from its level between the late 1950s and the mid-1990s, Israeli reserve units are far superior to any other international reserve units such as the US National Guard, being able to thrust into combat within days rather than months.

The IDF has been able to exploit the advantages of modern technology far more rapidly than any other major military power. Its ability to foreshorten the sensor-to-shooter link is unparalleled internationally. It has concentrated its investment on surveillance systems, real-time

digital battle management command and control systems and precision munitions. Israel was the first to deploy non-line-of-sight precision-guided missiles. These advanced capabilities would be decisive against hostile conventional forces that lacked comparable technology and capability, though they have proven far less effective in urban fighting against militia-type forces under rigid and overly conservative self-imposed rules of engagement.

Israel has significantly reduced its tube artillery order of battle. It is assessed that they have cut far too deep and now have inadequate means to generate suppressive fire against light infantry forces equipped with long-range direct fire anti-tank weapons.

It is estimated that the Armored Corps order of battle has been reduced from 36 to 24 brigades over the last decade, and, in the future, will likely be further reduced down to only 16 brigades by 2030. The future Armored Corps order of battle will, almost certainly, prove to be grossly inadequate if there is political upheaval in Egypt, Saudi Arabia or Jordan as, very likely, there will be, and, particularly, if Turkey becomes openly hostile to Israel. It is arguable that the Israeli military leadership has been naïve in assuming that it can continue to maintain overwhelming technological and tactical superiority well into the future, or that its current semi-friendly relations with many of the Sunni Arab states will be sustainable over the long term.

Israeli ground forces have simply been underfunded. They currently lack the ability to rapidly and decisively simultaneously overcome Hezbollah and Hamas at low cost. A limited increase in their budget of about 1% of the Israeli GDP would dramatically increase their near-term readiness and capability, thereby allowing Israel to reduce both its civilian and military casualties during operations against Hamas, Hezbollah, Syria and Iran. Doing so will dramatically improve the strategic options available to Israeli political leaders.

The future mobilizeable order of battle of both the Armored Corps and tube artillery should be increased. This would require an increase in the conscript filled active force structure in order to generate a larger number of mobilizeable reserves. This will also require the previously noted increase in annual defense funding.

Air Force

Over the last 30 years, the order of battle of the IAF has been significantly downsized. At the present time, it seems adequate given that its non-state enemies lack air forces or significant ground-based air defenses, while the Iranian air force is obsolescent. However, Turkey, Egypt, Saudi Arabia and the Gulf states cumulatively can deploy a much larger quantity of state-of-the-art fourth generation aircraft and have been the beneficiaries of western training and exposure to western tactics and doctrine. There is no guarantee that these states will continue to represent a benign threat in the long-term future. Consequently, it seems vital for Israel to increase the IAF's order of battle and replace its overage aircraft. For Israel, the high cost and limited air-to-air performance of the F-35, the only fifth generation US aircraft available, creates a huge problem. Replacing all of its existing F-16s with F-35s on a one-for-one basis would likely be financially impossible, while the F-35 lacks the aerodynamic performance to replace the F-15 as a premier air-to-air platform. The lack of an available F-15 replacement for use in the air superiority role creates a huge long-term problem for the IAF.

The IAF also lacks the funding necessary to procure adequate numbers of C-130J transports to replace its existing fleet of C-130s, V-22s for the special mission role, and new production heavy-lift helicopters to replace its aging CH-53s. It currently has an inadequate number of transports and heavy helicopters to support the available ground force's deep strike order of battle.

Israel currently has one of the world's most advanced C4ISR systems, which enables it to maximize the lethality of each attack sortie. It also has an extremely large and diverse inventory of high quality air-to-ground munitions. Because of its uniquely high aircrew-to-aircraft ratio and exceptionally competent ground support teams, it is able to generate the world's highest daily sortie rate. Today, the IAF can generate more daily fast-jet sorties than any conceivable combination of regional enemies. Moreover, each of these sorties would be of far higher relative quality. However, it is doubtful whether Israel can continue to maintain overwhelmingly superior technological superiority into the future.

Moreover, its aircraft depend on a relatively limited number of runways, which in the future will be vulnerable to preemptive destruction by enemy-delivered precision-guided ballistic missiles. This could severely disrupt Israeli sortie generation.

Air Defenses

Israel today deploys the world's most capable ground-based integrated air defense system. Nothing equivalent exists elsewhere. However, no missile yet developed can achieve a single-shot kill probability that approaches 100%. Capable air defense missiles are expensive and, consequently, the Israeli inventory of air defense missiles will inevitably be limited. The Israeli air defense system can be saturated and can never provide airtight protection. In the future, the system, which depends on a relatively small handful of high quality radars, will be vulnerable to preemptive attack and disruption by stealthy missiles.

Overemphasis on air defense systems, which has been politically attractive, is assessed to have been strategically catastrophic for Israel. The financial aid provided by the United States, dedicated to Israeli air defense systems, minimizes the likelihood of Israel preemptively mobilizing for offensive operations. This aid has been provided because it is in the strategic self-interest of the US, not because it best serves Israel's interests.

Navy

The Israeli navy currently has far fewer corvettes and fast attack craft than it requires and, almost all of these have never been fully outfitted with their designed number of fire-control systems. All but one cannot currently provide 360-degree active self-defense against inbound anti-ship missiles.

Israel is building towards a fleet of six highly capable diesel-electric attack submarines. With blue-white crewing, i.e., about 10 complete crews for the six boats, three to four of these could be continuously deployed. These submarines are all very likely able to launch long-range cruise missiles. However, they each carry very few reloads and, therefore, they do not, by themselves, represent a creditable deterrent force.

Israel has a substantial number of small relatively high-speed coastal patrol boats, which now mount stabilized 25mm cannon and relatively long-range missiles, which can precisely strike enemy ships or targets ashore, but which have very small warheads.

CONCLUSION

It seems evident that the IDF General Staff believes that Israel does not currently face the immediate threat of large-scale conventional warfare with its Arab neighbors but rather the threat of limited warfare by non-state actors in the Palestinian-controlled territories and the neighboring states. These non-state groups generally deploy infantry equipped with anti-tank guided missiles and mortars that can be mounted on light vehicles and motorcycles, and are only capable of limited cross-border attacks. However, these organizations are also equipped with large stocks of rockets and missiles of varying caliber, range and accuracy, and can cumulatively launch several thousand rockets daily, of which perhaps 5% can reach deep into Israel and have a profound impact on its citizens and strategic infrastructure. The rocket launchers and infantry deployed by these groups are often located within densely populated urban areas. It is also obvious that the General Staff has concluded that Israel must maintain a significant capability to strike remote hostile enemy state and non-state groups.

Based on the obvious threat assessment and its most recent decisions, the General Staff's current priorities seem to be as follows:

- The continued maintenance of a significant WMD deterrent
- The provision of real-time intelligence against both adjacent and remote threats
- The maintenance of regional air supremacy
- The provision of a multi-tier air-defense system capable of minimizing the impact of enemy rockets and missiles fired across the existing border

- The provision of static defenses against limited cross-border ground attacks by non-state infantry and the neutralization of its means of penetration, notably underground tunnels
- The ability to strike a very large number of targets in a short period of time in order to minimize the domestic cost of war by foreshortening any conflict
- The provision of a limited number of high readiness, technologically superior combined arms ground brigades, capable of relatively low cost offensive operations, including combat in urban areas conducted while minimizing collateral damage
- The provision of relatively high quality civil defense
- The defense of offshore energy assets

As a result of meeting these near-term priorities on a fixed limited budget, the General Staff has significantly downsized the order of battle of its Armored Corps and tube artillery and reduced training in large-scale maneuver warfare. It has also unacceptably reduced the combat readiness of its reserve ground units.

Unfortunately, what the General Staff has done today to meet current priorities will inevitably and irretrievably impact the Israeli mobilizeable order of battle and military capability up to two decades from now. No one can possibly predict the future threats that Israel might then face. Some of today's Arab "friends" will almost certainly face political upheaval and become tomorrow's enemies. Moreover, Israel today enjoys decisive technological superiority because of its unique ability to exploit evolving digital technology; but there is no assurance of its ability to continuously achieve such superiority in the future. In fact, what the IDF can uniquely deploy today will surely be readily available from the future international arms bazaar. This is compounded by the huge procurements by the rich Arab Gulf regimes, which are many times larger than the current annual IDF procurement budget. What fires east can just as easily fire west. A missile system that can intercept Iranian ballistic missiles can also intercept Israeli ballistic missiles. Because of these massive Arab investments in advanced technology, it is doubtful that Israel can continue to sustain its current advantage of overwhelming technological

superiority. This means that the Israeli General Staff may well have inappropriately over-adjusted its priorities to reflect what exists today but which will almost certainly no longer be the case tomorrow. Most important, it has simultaneously neglected preparations for large-scale offensive maneuver warfare that might be necessary in the future.

The impact of the assessed mistakes of the General Staff has been magnified by the decisions of the Israeli political leadership. Their direction to construct expensive, brittle, border fences and to prioritize ground-based air defense systems are, no doubt, politically popular, but may well represent a huge misallocation of Israel's limited financial resources. There should be no doubt that Israel would have been better served by increasing the readiness of its reserve ground forces, more rapidly deploying advanced force multiplier technologies such as the Trophy active defense system, and increasing the mobilizeable reserve order of battle. High readiness offensively oriented ground forces can be a far better deterrent than almost militarily useless fences and air defense systems that can be easily saturated and which are catastrophically vulnerable to stealthy future weapons.

In the end, all of these deficiencies are due to a combination of inadequate funding and bad choices made by the General Staff and worse decisions made by the politicians elected by the Israeli public. Israelis have unwittingly opted to accept numerous future casualties in exchange for a better life today. Feel good politics is no substitute for sound strategic planning. Only reasonably increasing the current ministry of defense funding by at least 1% of its GDP will enable Israel to more rapidly achieve its strategic objectives in any future conflict at a far lower human and material cost.

Notes

- 1 There are three widely used sources for the IDF's order of battle and weapon systems inventory: the annual *The Military Balance* issued by the London-based International Institute for Strategic Studies; various military assessments by Anthony Cordesman of the Washington DC-based US Center of Strategic and International Studies; and *The Regional Military Balance*, issued by the Tel Aviv-based Institute for National Security Studies. None of these sources generally goes beyond a simple numerical "bean count," which themselves are assessed to be often wrong. The only known references to have addressed both qualitative assessment and quantitative data are the following, all of which were solely developed by the author: "The Middle East Military Balance," *International Defense Review*, July 1986; "A Propensity for Conflict," Special Report No. 14, *Jane's Intelligence Review*, February 1997; and "Pre-empting Iran: A Military Assessment," *The Royal United Services Institute*, Vol. 158, No. 5, October 213.

It should be noted that the order of battle and material inventories presented in this study are often quite different from those provided by the above standard references.

- 2 Kenneth S. Brower, "Measuring Military Power," in *Building Sustainable and Effective Military Capability* (IOS Press, NATO Science Series), pp. 9-23, is the only known estimate of the cost impact of Israel's unique defense doctrine. It shows that Israel has been able to generate high quality maneuver battalions and fast jet sorties at a small fraction of the annual budgetary cost born by the U.S for similar battalions and combat sorties.
- 3 The IAF has long employed active duty, emergency posting and reserve aircrew within its squadrons irrespective of rank. No other international air force is known to do this. Israeli emergency posting (active aircrew assigned to training or non-vital staff positions) and reserve aircrews fly one or two sorties a day per week in order to maintain combat proficiency. The IAF has, therefore, been able to generate the highest wartime aircrew-to-aircraft ratio of any major international air force. Consequently, it can achieve far higher sustainable sortie rates than any known international air force. In the 1990s, the IAF maintained war reserves for a planned daily sortie rate of seven per F-16 and five per F-15. During Operation Desert Storm (1991), the USMC achieved a peak daily sortie rate of 2.6 for its forward-based Harrier jets. The daily sortie rate was only 1.25

for all other USAF and USN fast combat jets. The information on the IAF sortie rate was based on the author's interviews with uniquely knowledgeable U.S. experts. US daily sortie rates are publically available data.

- 4 Author assessment.
- 5 As an example of how equipment used by reserve forces is employed, the M-60A3 tank will be used. The IDF procured an adequate number of new production M-60A3 MBTs to fully equip three tank brigades in the early 1980s. Initially, only a limited proportion of these new tanks was allocated to active conscript-crewed battalions, most of which were immediately placed in storage for future use by the reserve crews who would subsequently be trained to operate this tank. Within a decade, the M-60A3 was no longer in active conscript service, as all could be crewed by previously generated reserve personnel, having been significantly modified in Israeli depots before entering IDF service. Subsequently, they were further upgraded to selectively incorporate newer technology. However, as the reserve personnel crewing these MBTs began to approach the age limit for mobilization in the early 2000s, the general staff decided not to further upgrade these tanks for another 24-year cycle of active and reserve service, though the Israelis had proven the ability to significantly upgrade their firepower, mobility and protection, as reflected by the advanced M-60T variant exported to Turkey.
- 6 Tanks and half-tracks figures are primarily based on a declassified CIA assessment. A tank brigade at the time comprised two tank battalions, an armored infantry battalion mounted on half-tracks and a truck-mounted motorized infantry battalion. However, the tank battalions of the two reserve armored brigades were generally significantly understrength. Tank companies had a TOE of 17 MBTs (based on three MBT platoons), plus an organic platoon of armored infantry mounted on half-tracks.
- 7 The order of battle, unit table of organization and the number of tanks and half-tracks in 1967 was generated by the author based on the books and periodical articles contained in the bibliography, declassified US CIA estimates and the *History of the IDF Ordnance Corps*.
- 8 The order of battle, unit table of organization and number of tanks and armored fighting vehicles in 1973 were developed by the author based on data contained in declassified US National Security Council (NSC) minutes; the declassified testimony of Maj. Gen. Israel Tal to the Agranat inquiry commission; *History of the IDF Ordnance Corps*; and books and periodical articles contained in the bibliography.

- 9 These assessments are the professional judgment of the author, and were primarily influenced by Tal's above testimony and his comments to a professional colleague of the author. The post-1973 war transfer of 600 M-125A1 self-propelled 81mm mortars to the IDF was revealed in US Congressional testimony.
- 10 In the aftermath of the 1973 war, most international analysts concluded that the IDF's losses were due to its failure to execute combined arms operations. This assessment became the almost universally accepted conventional wisdom. The author, like Israeli military leaders, concluded otherwise. The author had long ago argued that it made no sense to have 11 men behind one inch of armor protecting four men protected by 11 inches of armor, and that suppression was the lesson to be learned when operating in open terrain. Mortars, machine guns and appropriate tank shells were assessed to be far more important than additional vulnerable infantry mounted on light armored personnel carriers.
- 11 The 1977 order of battle and material inventory of the IDF's Armored Corps was calculated by the author primarily based on the *History of the IDF Ordnance Corps* and declassified US NSC minutes reporting US arms supplies to Israel in the aftermath of the 1973 war. The declassified CIA's estimated forecast of future Israeli strength proved to be consistently low. Sources told the author that the three new Corps headquarters were initially commanded by generals Tal, Adan and Sharon, all of whom were then serving as reservists.
- 12 Post-1976 US exports to Israel of new production tanks and armored vehicles were extensively reported by the US media. The fact that most Centurion tanks received by Israel were actually delivered by the US has not been noted elsewhere. These tanks had been procured by the US for NATO under the Mutual Defense Assistance Program (MDAP) and had reverted to US ownership after they were no longer required by the user nations. The annual production rate of Merkava MBTs (maximum of 180 per year with one working shift or 300 per year working shifts) was provided to the author by a uniquely knowledgeable US armored vehicle engineer. This engineer had acted as an advisor to Gen. Tal during the creation of the production facility and the evolution of the Merkava design. This source provided the information that initial production rate was one brigade set per year.
- 13 The 1979 order of battle data was provided by a classified US report published by Wikileaks.
- 14 The production numbers of TARS and Honeywell thermal elbows delivered to Israel were published as news items in the *International Defense Review*.

- 15 The reported change from armored infantry to mechanized infantry brigades was based on information provided by a knowledgeable Israeli source.
- 16 The 1987 Armored Corps order of battle was initially developed by the author. The number of IDF tank divisions in 1987 generated by the author was subsequently confirmed by a classified US message published by Wikileaks. The estimated table of organization for IDF tank divisions was developed by the author based on the books and articles contained in the bibliography.
- 17 By 1990, SIBAT was offering surplus IDF M-48A5, Shot and Tiran main battle tanks for sale, meaning that the reserve units that had used these vehicles had been disbanded.
- 18 The 2003-2004 reorganization was widely reported by the Israeli media.
- 19 The intent of the new Israeli minister of defense to increase the mobilizeable order of battle was widely reported by the Israeli media, as was the decision to increase the number of trained conscript tank crews generated annually by adding a fourth tank company to active tank battalions. The author has viewed photos of Israeli tanks with the markings for the fourth tank company in a battalion.
- 20 The downsizing of the Armored Corps order of battle in 2013-2014 was widely reported by the Israeli media. The reported impact of this downsizing is the author's professional assessment.
- 21 The reported inventory of serviceable armored vehicles was developed by the author based on the references noted in the introduction and the books and articles in the bibliography.
- 22 The previous IDF chief of staff reported that Israeli divisions would be increased from three to four brigades. Based on the number of tank and mechanized infantry brigades estimated to be available at the current time, the author has estimated that the IDF now likely deploys true combined arms divisions.
- 23 The 1956 infantry order of battle is based on Moshe Dayan's *Diary of the Sinai Campaign*.
- 24 The 1956 table of organization of infantry and paratroop units, and the equipment used by these units, was based on *Sinai Victory* by SLA Marshall.
- 25 The 1967 infantry order of battle was based on the books and articles in the bibliography, as was the equipment used by the infantry in 1967.

- 26 The 1973 infantry order of battle was developed by the author based on the books and articles noted in the bibliography.
- 27 After the 1973 war, the US provided Israel with 80,000 M-16A1 rifles. The IDF ordered 1,000 new production Dragon ATGM launchers and 10,000 missiles in the late 1970s. These ATGMs were reportedly organic to each infantry platoon. It is the author's professional estimate that each IDF tank division included an anti-tank battalion with 36 TOW ATGM launchers mounted on modified M-113A1 chassis and that each infantry brigade had an anti-tank company equipped with 12 TOW ATGM launchers mounted on M-151 jeeps. Before Israel was able to acquire large numbers of FLIR sites, all IDF ATGM units were provided with organic 60mm mortars for night illumination.
- 28 The estimated infantry order of battle in 1977 was based on the known number of tank divisions and armored infantry brigades.
- 29 The creation of new active infantry brigades and the number of newly formed active territorial defense light infantry battalions was widely reported in the Israeli media. The number of annual reservists generated each year is the inevitable result of the active force structure.
- 30 The current infantry order of battle was developed by the author based on the estimated number of trained infantry reservists generated over the previous 21 years.
- 31 The estimated IDF artillery and anti-tank assets in 1956 and 1967 were primarily generated by the author based on the *History of the IDF Ordnance Corps*, declassified CIA reports and the books and articles listed in the bibliography.
- 32 Photographic evidence exists of 90mm half-track mounted anti-tank guns being used during the 1967 war. The characteristics of this smooth bore weapon were based on detailed data published by *International Defense Review* as well as the 1990 SIBAT surplus weapon catalogue.
- 33 Waronline.com provided an excellent report on the IDF's artillery corps order of battle during the 1973 war. However, this report only included precise data units that were in direct contact with the Syrian and Egyptian militaries. Therefore, it is very likely that it underestimated the number of IDF anti-tank gun and towed artillery battalions arranged on secondary fronts.
- 34 The assessments provided are the professional judgments of the author. They are consistent with the known changes in the IDF's order of battle and material holdings after the 1973 war.

- 35 Declassified US NSC minutes provide detailed data on prewar Israeli artillery equipment and war reserve ammunition stores, as well as postwar US supplies of artillery and ammunition to Israel. The additional L-33 and M-68 self-propelled artillery pieces generated by Israel between 1974 and 1977 were estimated by the author, as were the estimated number of captured Soviet M-46 130mm guns and D-30 122mm howitzers added to the Israeli inventory.
- 36 Changes in the table of organization of the artillery brigade organic to each Israeli tank division and the addition of a heavy mortar battalion to each maneuver brigade were estimated by the author.
- 37 Ammunition war reserves can be calculated based on the number of tubes and the planned allowance of shells per tube. Based on Gen. Tal's testimony, the 1973 IDF's planning factor was a war reserve of 800 rounds per medium tube, which was apparently expected to provide 14 days of sustained fire support. It is the author's assessment that the war reserve of about 60 rounds per artillery tube per combat day was grossly inadequate. It has been widely reported that the IDF's goal was to increase its planning factors for war reserve munitions to reflect an increase from 14 to 28 days of sustained combat, at a significantly higher level of daily expenditures.
- 38 The mid-1980s IDF's inventory of artillery was estimated by the author on the basis of the books and articles listed in the bibliography.
- 39 The assessment of the adequacy of this order of battle and the differences between US and Israeli practices is based on the judgment of the author.
- 40 The author was told about the Nimrod by a knowledgeable international military source in the mid-1980s. The Tammuz, which represented a major technical achievement, remained secret until exported to Britain almost 20 years after it entered service in the IDF. Only then was it publicly revealed.
- 41 The US offer of 600 M-109A1s is available in US government reports of excess defense article transfer. Since 1992, the IDF has received the following major equipment under this program:
- 165 MLRS Launchers
 - 299 M-106A1/M-1064A2 120mm SP Mortars
 - 359 M-548A1 Cargo Vehicles
 - 349 M-577A1 Command Vehicles

- 450 M-113A1 TOW Launchers
- 72 M-163A1 Vulcan SP AA Vehicles
- 9 M-1059 Smoke Generator Vehicles
- 29 M-973 Armored Snowcats
- 66 HUMVEE 4x4 Vehicles
- 660 HEMTT 8x8 Heavy Trucks
- 251 5 Ton 6x6 Trucks
- 510 Miscellaneous Trailers
- 155,110 M-16A1/A2/A3 Rifles
- 1,500 M-2 12.7mm Heavy Machine Guns
- 1,600 VRC-12/46 Radios
- 120 Lantrin Pods (50 Nav/70 Attack)
- 145 AGMB-145 Missiles + 12 Guidance Pods
- 72 AH-1E/F Attack Helicopters
- 3 TA-4J Jet Trainers
- 9 F-15D Combat Aircraft

These major systems, most of which remain in service with the IDF, are estimated to have a 2017 replacement value of about \$5.6 billion. The IDF has also received ammunition and logistical supplies that are estimated to increase the replacement value of the material received under this program to well over \$7 billion. In addition, US vehicles, ammunition and supplies, with an estimated replacement value of over \$3 billion are stored in Israeli facilities which are solely under the control of the IDF. It should be noted that the three standard references noted above generally never incorporate the impact of these transfers on the IDF's material inventory.

- 42 The current IDF inventory of artillery systems is the author's estimate.
- 43 The assessment of the current IDF artillery corps order of battle reflects the professional judgment of the author.

- 44 The IDF's 1956 air defense assets are primarily based on a declassified CIA estimate.
- 45 The IDF's 1967 air defense assets are primarily based on *The June 1967 Six Day War* by Shlomo Aloni.
- 46 *The History of the IDF Ordnance Corps* provides detailed lists of the potentially useable military equipment captured during the 1967 and 1973 wars. Declassified CIA reports provide the number of IDF Hawk batteries and missile inventories in 1973.
- 47 The mid-1980s air defense order of battle was developed by the author based, in part, on *Jane's All the World Air Forces*, which the author judged to provide a reasonable order of battle for IDF air defenses.
- 48 The adjustments in the IDF air defense order of battle reflect the author's professional estimate.
- 49 The current IDF air defense order of battle was estimated by the author based on the books and articles contained in the bibliography.
- 50 The inventory of serviceable IAF aircraft available in 1949 and thereafter can be determined with considerable accuracy based on data contained in the books and articles provided in the bibliography. However, in the author's judgment, aircraft are merely systematically organized spare parts on wheels. When assessing an air force, it is the author's judgment that the number of combat aircraft sorties that can be generated daily, and the quality of those sorties, determines the capability of an air force. The assessments of daily sortie generation and quality are solely those of the author.
- 51 Declassified CIA reports provide data on 1973 IAF helicopter and transport aircraft inventory. Declassified US NSC minutes provide data on the wartime and post-war transport aircraft and helicopter deliveries to Israel.
- 52 Photographic evidence is available showing the US ECM pods and precision-guided weapons employed by the IAF during the 1973 war.
- 53 The assessment of the IAF's capability to counter the Soviet supplied SAM array was based on the author's experience studying these systems, the books and articles listed in the bibliography and his extensive knowledge as a defense analyst.
- 54 The delivery by the US to Israel of air-launched decoys and ground-launched Standard ARM missiles were first revealed to the author in the 1970s by knowledgeable US experts. The existence of ground-launched Standard ARM

missiles in Israeli service was inadvertently publically revealed by a solicitation for maintenance support in the US government publication *Commerce Business Daily*. The existence of the two-stage Shrike missiles, launched from a converted M-50 chassis was first publically revealed in a photo on the back cover of a hobbyist periodical.

- 55 By 1982, the IAF is estimated to have maintained a diverse war reserve inventory of 12,000-15,000 precision guided weapons. These included laser guided bombs, Tadmint, Hoboe, Walleye, GBU-15, and Maverick electro-optically guided bombs and missiles, as well as air and ground launched Shrike and Standard ARM missiles.
- 56 IAF sortie generation capability in 1982 was estimated by the author based on the number of aircrews and an assumed sustained sortie rate per day of 2.5 per aircrew. This sortie rate was consistent with IAF sortie generation during the 1967 and 1973 wars.
- 57 The author learned of IAF aircrew-manning practices and planned F-16 and F-15 daily sortie generation rates in 1992 from uniquely knowledgeable international sources. This information was subsequently confirmed by the author's discussion with other international military aviation leaders.
- 58 The estimate of the capability of the IAF in the late 1980s was developed by the author based on information on the number of mobilizeable aircrews provided by a unique US source. Because of its ability to generate as many as 3,000 combat sorties daily and its leading edge electronic warfare capability and advanced weapons, the author reached the conclusion that the IAF had become the world's third most powerful air force.
- 59 The author was told by a uniquely qualified source of this major shift in role and mission assignments in the late 1980s. US critics of the Lavi Program never recognized or reported on the impact of this major decision. The author cannot decide if these vocal critics were simply uninformed and/or militarily illiterate or, less probably, deliberately ignoring this major change because the USAF would not have wanted the US Congress to consider this cost-saving concept of operations.
- 60 The increased MGTOW of updated Israeli CH-53s was revealed in *Jane's Defense Systems Modernization*.
- 61 Some of the IAF's AH-1s had been upgraded to fire non-line-of-sight Spike missiles. These updated attack helicopters remain very capable. It is the author's estimate that some of these attack helicopters remain in useable storage and could be rapidly reactivated for use by aircrews that remain qualified.

- 62 An exceptionally long runway was completed several years ago at the Nevateem Air Field. Immediately adjacent to the runway are five hangars that are not large enough to service the transport aircraft based at this airfield. A long runway is only required for an aircraft which lands or takes off at very high speeds. It is not required for the airframes currently in Israeli service. Consequently, it is the author's assessment that this runway is meant for use by a very high speed UAV.
- 63 The author was told by a uniquely knowledgeable source of the existence of an Israeli ground-to-air data link as well as an unjammable air-to-air data link. This source also noted the desire of the Israeli air staff to maintain a capability for real-time targeting and battle damage assessment. Over 25 years ago, Israeli aircraft could store, receive and transmit digital imagery, including terminal target images from E/O weapons.
- 64 Based on information provided to the author by uniquely knowledgeable US individuals, the IAF maintains war reserve munitions, spares and consumables adequate to support the generation of seven daily sorties for each F-16 and five for each F-15 for one month. This is consistent with their mobilizeable air crew-to-aircraft ratio of about 2.5:1.0. This rate is applicable to sorties executed out to a range of about 800km. As the range of sorties increases beyond 800km, the number of sorties that each aircraft can generate daily will be progressively reduced because the number of flight hours achievable per day will determine the maximum number of daily sorties that each aircraft can generate, not aircrew endurance. During Operation Desert Storm, USAF F-15s and F-16s typically generated about 1.25 daily sorties which were about 5.25 hours long. Over 85% of these aircraft did not require maintenance after completion of a sortie. The author's estimate of 3.3 long-range sorties per day for the IAF reflects this prior combat experience, an estimated 45 minutes turnaround time for returning serviceable aircraft, and a reasonable mean time to repair for returning aircraft that require flight line maintenance. This intense sortie rate is consistent with the unusually high available number of Israeli aircrew for each of their aircraft. No other international air force can achieve this daily sortie rate. Long ago, senior USAF officers requested that the author suppress the publication of this information because they reported that it would reduce the number of USAF command billets.
- 65 The number of weapons that an aircraft can deliver depends on the range of the mission. Over short-range, the pylons used for external fuel tanks can carry weapons. As far as is known, the IAF has yet to deploy smart multiple ejector racks which can mount large weapons. It is the author's estimate that the IAF almost certainly now fields smart multiple ejector racks. Nevertheless, even without the availability of these racks, the IAF could deliver up to about

5,000 large PGMs daily. If Israel has developed a smart ejector rack capable of mounting multiple large weapons, this number would significantly increase. A pylon that can carry a 2,000lb PGM can easily mount two or four smaller PGMs. There should absolutely be no doubt that the IAF can engage and destroy thousands of targets daily.

- 66 The author was told by a former trainee the number of fast-jet aircrew generated annually by the IAF in the 1990s. At that time, it was apparent that the IAF was only replacing aircrew no longer capable of conducting combat missions and that the number of combat qualified aircrew was being reduced in accordance with the shrinking order of battle.
- 67 The F-35B has significantly less range than the F-35A. It is more difficult to maintain and more costly. Its thrust is so destructive that it cannot safely operate from simple conventional concrete launch pads. It is the author's assessment that acquiring the F-35B makes no operational sense, except for its potential use in the nuclear second strike role.
- 68 Israel is currently deciding whether to order 25 new production F-15s or F-35s. The F-15 will generate a higher daily sortie rate (because the stealth coating of the F-35 must be repaired after about five sorties and then cured for 24 hours in an environmentally protected space), will deliver far more ordnance per sortie, can carry much larger weapons, and will provide much longer range. Because of these factors, it is the author's assessment that the IAF will opt for the F-15, particularly since the F-35 will remain in production for at least another decade and will be available later at a lower cost than it is today.
- 69 The F-16C aggressor aircraft would, very likely, be employed in wartime as combat aircraft, as would any other serviceable F-16s being used as advanced trainers. The F-35A lacks the speed, acceleration and high altitude performance of up-graded Israeli single-seat F-15A/Cs. With no access to the now out of production, very high quality F-22, it is assessed that the IAF will face a difficult air superiority problem in the future when its potential enemies will deploy high performance, stealthy fifth generation Russian and/or Chinese air superiority aircraft.
- 70 The author has professionally studied Israeli SAAR 2, 3, 4, and 5 surface combatants during his long association with the US Navy's Comparative Naval Architecture Program.
- 71 The navy's order of battle in the 1973 war and the impressive result of the naval battles are primarily based on *The Boats of Cherbourg* by Abraham Rabinovich and *Flotilla 13* by Ze'ev Almog. It is the author's assessment that, because of

their low frontal radar cross-section, effective use of long and short-range chaff and innovative appropriate tactics, Israeli fast attack craft were then the world's most effective small surface combatants.

- 72 In the author's assessment, a relatively large IDF armored force inserted south of the Suez Canal would have been immediately free to maneuver in a large area that had minimal SAM defenses. Therefore, this armored force could have been very effectively supported by the IAF. In the author's view, using this powerful force to conduct deep raids in force across the Egyptian military's exposed and vulnerable logistical heartland would have led to the likely collapse of the Egyptian army without requiring the IDF to fight a difficult and bloody breakthrough battle, as it actually did.
- 73 The author reviewed the Dutch conceptual design for the SAAR 5. He advised the Israeli project manager that its full load displacement had been underestimated by about 30%, and that the increased displacement would result in the significant reduction in the achievable speed. The project manager asked that these findings be suppressed and never reported this back to the ministry of defense. The original concept design included three fire-control radars arranged to allow at least two to cover every approach angle, 64 Barak VLS cells, and 8 Gabriel ASCM canister launchers. Ultimately, in order to minimize the displacement's growth, the outer hull of the SAAR 5 was constructed of steel, while all internal decks and bulkheads were constructed of lightweight aluminum. Nevertheless, at delivery, the full load displacement of the SAAR 5 was similar to that estimated by the author several years earlier.
- 74 It is the author's assessment that the displacement of the latest version of the Dolphin class submarines has grown well beyond that required to account for the additional low power air independent propulsion system. Adding extra storage for cruise missile reloads, which necessarily are located far forward adjacent to the bow torpedo tubes, would have required an offsetting adjustment in the longitudinal center of gravity and/or the longitudinal center of buoyancy in order to maintain the submarine's trim when submerged. Consequently, it is the author's assessment that the significant increase in the number of stored cruise missiles largely accounts for the substantial increase in the submarine's dimensions and displacement.
- 75 The increased number of available submarine crews was reported by the Israeli media. Increasing the number of trained crews is assessed to be vital if a barely minimum number of these submarines are to be continuously deployed as a second strike nuclear deterrent. An order of battle of six submarines provides

for the continuous availability of five, with one always undergoing major maintenance. The currently planned premature replacement of the first batch of three Dolphin submarines by 2030 suggests that the potential increase in the number of embarked cruise missiles is considered strategically vital and worth an otherwise unnecessarily \$2 billion investment.

- 76 The estimated armament mounted by these small frigates is based on data available on the internet. The SAAR 6 will be more heavily armed and far more capable than other much larger international combatants.

BIBLIOGRAPHY

Books

- Adan, Avraham, *On the Banks of the Suez*, Arms and Armour Press, 1980
- Allon, Yagal, *The Making of Israel's Army*, Bantam Books, 1971
- Almog, Ze'ev, *Flotilla 13*, United States Naval Institute, 2010
- Aloni, Shlomo, *Arab-Israeli Air Wars 1947-82*, Osprey Aviation, 2001
- Aloni, Shlomo, *Israeli A-4 Skyhawk Units in Combat*, Osprey Publishing, 2009
- Aloni, Shlomo, *Israeli Air Force 107 Squadron*, Air Space DOC, 2005
- Aloni, Shlomo, *Israeli Air Force de Havilland Mosquito*, Air Space DOC, 2006
- Aloni, Shlomo, *Israeli Air Force Tayeset 119*, Air Space DOC, 2007
- Aloni, Shlomo, *Israeli F-15 Eagle Unit in Combat*, Osprey Publishing, 2006
- Aloni, Shlomo, *Israeli F-4 Phantom II Aces*, Osprey Publishing, 2004
- Aloni, Shlomo, *Israeli Mirage and Nesher Aces*, Osprey Publishing, 2004
- Aloni, Shlomo, *The June 1967 Six Day War, Volume A – Operation Focus*, IsraDecal Publications, 2008
- Aloni, Shlomo, *Vultures Over Israel*, Schiffer, 2011
- Ami International, *Missile Systems of the World*, Raytheon, 1999
- Amir, Amos, *Fire in the Sky*, Pen and Sword, 2005
- Armitage, M. J. and Mason, R. A., *Air Power in the Nuclear Age*, Macmillan, 1985
- Asher, Jerry and Hammel, Eric, *Duel for the Golan*, William Morrow and Company, 1987
- Atkinson, Edward B., *The Powder Keg*, NOVA Publications, 1996
- Badri, and Zohdy, *The Ramadan War 1973*, Hippocrene Books, 1978
- Ball, Ray, *Camouflage & Markings Number 3, the Israeli Air Force*, Guidelines Publications
- Barker, A. J., *Arab Israeli Wars*, Ian Allen Ltd., 1980

- Barker, A. J., *Six Day War*, Ballantine Books, 1974
- Barker, A. J., *The Yom Kippur War*, Ballantine Books, 1974
- Bartov, Hanoch, *Dado 48 Years and 20 Days*, Ma'ariv Book Guild, 1981
- Bondy, Zmora and Bashan, *Mission Survival*, Sabra Books, 1968
- Borovik, Yehuda, *Israeli Air Force, 1948 to the Present*, Arms and Armour Press, 1984
- Brown, Ashley, *Strike From the Sky*, Villard Books, 1986
- Camouflage and Markings of the Israeli Air Force, 1967-2001*, Scale Aircraft Monographs, 2001
- Cohen, Eliezer, *Israel's Best Defense*, Orion Books, 1993
- Collins, Larry and La Pierre, Dominique, *O Jerusalem*, Simon and Schuster, 1972
- Combat Fleets of the World*, United States Naval Institute, 1986/87
- Cordesman, Anthony H., *Jordanian Arms and the Middle East Balance*, Middle East Institute, 1983
- Cordesman, Anthony H., *Perilous Prospects*, Westview Press, 1996
- Cordesman, Anthony H., *The Military Lessons of the Arab-Israeli Conflicts: Past and Future*, Whitehall Paper, Royal United Services Institute for Defense Studies, 1986
- Dayan, Moshe, *Diary of the Sinai Campaign*, Harper and Rowe, 1965
- Demchak, Chris C., *Complex Technologies, Conflicted Organization*, Annual Meeting of the American Political Science Association, 1994
- Dunstan, Simon, *Centurion vs. T-55 Yom Kippur War 1973*, Osprey Publishing, 2009
- Dunstan, Simon, *The Centurion Tank in Battle*, Osprey, 1981
- Dunstan, Simon, *The M113 Series*, Osprey, 1983
- Dunstan, Simon, *The Six Day War 1967: Jordan and Syria*, Osprey Publishing, 2009
- Dupuy, T. N. and Martell, Paul, *Flawed Victory*, Hero Books, 1986
- Dupuy, T. N., *Attrition: Forecasting Battle Casualties and Equipment Losses in Modern War*, Hero Books, 1990

- Dupuy, T. N., *Understanding War*, Paragon House, 1987
- Dupuy, Trevor N., *Elusive Victory*, Harper and Rowe, 1978
- Efrati, Yoav, *Colors and Markings of the Israeli Air Force*, IsraDecal Publications, 2005
- Eshel, David, *Born in Battle Number 6, The Six Day War*, Eshel-Dramet Limited, 1979
- Eshel, David, *Chariots of the Desert*, Brasseys Defense Publishers, 1989
- Eshel, David, *The Lebanon War, 1982*, Eshel-Dramet Limited, 1982
- Francillon, Rene J., *World Military Aviation 1997-98*, United States Naval Institute, 1997
- Friedman, Norman, *World Naval Weapon Systems*, United States Naval Institute, 1989
- Gabriel, Richard A., *Operation Peace for Galilee*, Hill and Wang, 1984
- Gal, Reuven, *A Portrait of the Israeli Soldier*, Greenwood Press, 1986
- Gannon, Tom, *Israeli Half-Tracks, Volumes One and Two*, Barbarossa Books, 2008
- Gelbart, Marsh, *Modern Israeli Tanks and Infantry Carriers 1985-2004*, Osprey Aviation, 2004
- Golan, Mathi, *The Hal Parade in Jerusalem*, Mol-Art Limited, 1973
- Green, Stephen, *Living by the Sword*, Amana Books, 1988
- Gunston, Bill, *Israeli Air Force*, Salamander Books, 1982
- Gur, Mordechai, *The Battle for Jerusalem*, Popular Library, 1978
- Hammel, Eric, *Six Days in June*, Charles Scribner's Sons, 1992
- Heller, Tamari and Eytan, *The Middle East Military Balance*, Multiple Years, Jaffee Center for Strategic Studies
- Herzog, Chaim, *The Arab-Israeli War*, Arms and Armour Press, 1982
- Herzog, Chaim, *The War of Atonement, October 1973*, Little, Brown and Company, 1975
- Hilmes, Rolf, *Main Battle Tanks*, Brassey, 1987
- Huertas, Salvador Mafe, *Mirage, The Combat Log*, Schiffer, 1996
- Huertas, Salvador Mafe, *The Israeli Air Force, 1947-1960*, Schiffer, 1998

- Jane's All the World's Aircraft*, 1951-Present
- Jane's Armour and Artillery*, 1975-Present
- Jane's Fighting Ships*, 1951-Present
- Jane's Weapon Systems*, 1977-Present
- Kahalani, Avigdor, *A Warrior's Way*, SPI Books, 1994
- Katz, Sam, *Israeli Defense Forces Since 1973*, Osprey, 1986
- Katz, Samuel M., *Armies in Lebanon, 1982-84*, Osprey, 1985
- Katz, Samuel M., *Battleground Lebanon*, Concord Publications, 1990
- Katz, Samuel M., *Fire and Steel*, Pocket Books, 1996
- Katz, Samuel M., *Follow Me!*, Arms and Armour Press, 1989
- Katz, Samuel M., *Israel's Air Force*, Motorbooks International, 1991
- Katz, Samuel M., *Israel's Armor Might*, Concord Publications, 1989
- Katz, Samuel M., *Israel's Army*, Presidio Press, 1990
- Katz, Samuel M., *Israel's Cutting Edge*, Concord Publications, 1990
- Katz, Samuel M., *Israeli Elite Units Since 1948*, Osprey Publishing, 1988
- Katz, Samuel M., *Israeli Elite Units*, Arms and Armour Press, 1987
- Katz, Samuel M., *Israeli Special Forces*, Motorbooks International, 1993
- Katz, Samuel M., *Israeli Tank Battles*, Arms and Armour Press, 1988
- Katz, Samuel M., *Merkava I, II, III*, Concord Publications, 1992
- Katz, Samuel M., *Merkava Main Battle Tank 1977-1996*, Osprey Publishing, 1997
- Katz, Samuel M., *Modern Israeli Tanks and Combat Vehicles*, Arms and Armour Press, 1987
- Katz, Samuel M., *Tools of the Trade, Weapons, Gear & Uniforms of the IDF*, Concord Publications, 1991
- Kipnis, Yigal, 1973, *The Road to War*, Just World Books, 2013

- Klein, Adreas and Aloni, Shlomo, *Israeli Phantoms, Volumes One and Two*, Double Ugly Books, 2009
- Kurzman, Dan, *Genesis 1948*, The World Publishing Company, 1970
- Laffin, John, *The Israeli Army in the Middle East Wars, 1948-73*, Osprey, 1982
- Land Equipment Excess Inventory*, State of Israel Ministry of Defense
- Lorch, Carlos and Lorch, Netanel, *Shield of Zion*, Howell Press, 1991
- Luttwack, Edward and Horowitz, Dan, *The Israeli Army*, Harper and Rowe, 1975
- Mahaerob, Robert, *Centurion Tanks of the IDF, Volumes One and Three*, SabingaMartin Publications, 2011
- Manasherob, Robert, *Israeli HalfTracks Volume One*, SabingaMartin Publications, 2010
- Manasherob, Robert, *Israeli Wild and Cruel Cats, Volume One*, SabingaMartin Publications, 2011
- Manasherob, Robert, *Lioness & Lion of the Line, Volumes One, Two, Five & Six*, SabingaMartin Publications, 2007
- Marshall, S. L. A., *Sinai Victory*, William Morrow and Company, 1958
- Marshall, S. L. A., *Swift Sword*, American Heritage Publishing Co., 1967
- Mass, Michael, *Magach 6B Gal, Parts One & Two*, Desert Eagle Publishing, 2010
- Mass, Michael, *Merkava Siman 3*, Desert Eagle Publishing, 2007
- Mass, Michael, *Merkava Siman 3D*, Desert Eagle Publishing, 2012
- Mass, Michael, *Merkava Siman 4*, Desert Eagle Publishing, 2010
- Mass, Michael, *Warmachine Number 10, IDF Tiran*, Verlinden Publications, 1991
- Mass, Michael, *Warmachine Number 11, Merkava*, Verlinden Publications, 1992
- Mass, Michael, *Warmachine Number 4, Israel M4 Sherman and Derivatives*, Verlinden Publications 1990
- Morris, Benny, *1948*, Yale University Press, 2008
- Mostek, Jan, *Israeli Armour in Detail, Volumes One & Two*, Wings and Wheels Publications

- Myszka, John, *Israeli Military Vehicles, 50 Years*, Mouse Trap Enterprises, 1998
- Naval Equipment Excess Inventory*, State of Israel Ministry of Defense
- Neff, Donald, *Warriors Against Israel*, Amana Books, 1988
- Nordeen, Lon, *Fighters Over Israel*, Orion Books, 1990
- Oren, Michael B., *Six Days of War*, Oxford University Press, 2002
- Peres, Shimon, *David's Sling*, Weidenfeld and Nicholson, 1970
- Pollack, Kenneth M., *Arabs at War*, University of Nebraska Press, 2002
- Rabinovich, Abraham, *The Battle for Jerusalem*, Jewish Publication Society of America, 1972
- Rabinovitch, Abraham, *The Yom Kippur War*, Schocken Books, 2004
- Russell, Lee and Katz, Sam, *Israeli Defense Forces, 1948 to the Present*, Arms and Armour Press, 1985
- Safran, Nadav, *From War to War*, Pegasus, 1969
- Sales Directory of Ground Forces Equipment and Systems*, State of Israel Ministry of Defense, April 1989
- Sales Directory of Israel Air Force Equipment*, State of Israel Ministry of Defense, January, 1989
- Schiff, Ze'ev, *A History of the Israeli Army*, Macmillan Publishing, 1981
- Schiff, Zeev and Rothstein, Raphael, *A History of the Israeli Army (1870-1974)*, Straight Arrow Books, 1974
- Spector, Iftach, *Loud and Clear*, Zenith Press, 2009
- The Military Balance*, Multiple Years, International Institute for Strategic Studies
- Tyler, Patrick, *Fortress Israel*, Farrar, Straus and Giroux, 2012
- Van Ceveld, Martin, *Command in War*, Harvard University Press, 1985
- Van Creveld, Martin, *The Sword and the Olive*, Public Affairs, 1998
- Von Pivka, Otto, *Armies of the Middle East*, Patrick Stephens Cambridge, 1979
- Weiss, Ra'anana and Koren, Alon, *F-16C/D Barak*, IsraDecal Publications 2003

Weiss, Ra'anana and Koren, Alon, *F-15 Baz*, IsraDecal Publications

Weiss, Ra'anana and Aloni, Shlomo, *F-4E Phantom Kurnass*, IsraDecal Publications, 2008

Weiss, Ra'anana and Aloni, Shlomo, *IAI Kfir*, IsraDecal Publishing, 2007

Weiss, Ra'anana and Efrati, Yoav, Israeli Aircraft Industry Kfir, IsraDecal Publications, 1995

Weiss, Ra'anana and Efrati, Yoav, *McDonnell Douglas A-4 Skyhawk*, IsraDecal Publications, 2001

Weiss, Ra'anana, *F-15I Ra'am in IAF Service*, IsraDecal Publications 2006

Weiss, Ra'anana, *F-16I Sufa in IAF Service*, IsraDecal Publications, 2005

Williams, Louis, Israel Defense Forces, *A People's Army*, Ministry of Defense Publishing House, 1989

Yonay, Ehud, *No Margin for Error*, Pantheon, 1993

Zaloga, Steven J., *Armour of the Middle East Wars, 1948-78*, Osprey, 1981

Zaloga, Steven J., *Israeli Tanks and Combat Vehicles*, Arms and Armour Press, 1983

Zaloga, Steven J., *Modern Soviet Combat Tanks*, Osprey, 1984

Zaloga, Steven J., *Tank Battles of the Mid East Wars, 1948-1973*, Concord Publications, 1996

Zaloga, Steven J., *Tank Battles of the Mid East Wars, 1973 to the Present*, Concord Publications, 1998

Zaloga, Steven J., *The M47 and M48*

Periodicals

"10 Years, Yom Kippur War," *Defense Update*, Number 42, pgs. 2-65

"A Little Bit of This, A Little Bit of That," *Air International*, January, 1999, pgs. 42-54

"A Technological History of the IDF," *IDF Journal*, Summer, 1988, pgs. 22-31

"A-4 Ahit," *Air Forces Monthly*, March, 2005, pgs. 56-60

"Aging Aircraft Can Fly Forever," *Air Forces Monthly*, September, 2004, pgs. 56-59

- “Air Defense Suppression,” *Defense Update*, December, 1986, pgs. 45-57
- “Air Warfare in the Middle East,” *Air Forces Monthly*, Number 133, pgs. 46-51
- “Air Warfare in the Middle East,” *Air Forces Monthly*, Number 134, pgs. 30-34
- “Angels Over Fire,” *Air Forces Monthly*, December, 1998, pgs. 24-29
- “Centurion,” *War Data*, Number 1, pgs. 37-49
- “Country Briefing Israel,” *Jane’s Defense Weekly*, Volume 25, Number 25, pgs. 53-75
- “Country Briefing: Israel,” *Jane’s Defense Weekly*, February 18, 1995, pgs. 29-40
- “Country Capability Israel,” *Jane’s Defense Systems Modernization*, Volume X, Number 1, pgs. 17-25
- “Davids Deltas,” *Air Enthusiast*, January-February, 2003, pgs. 38-49
- “Davids Deltas,” *Air Enthusiast*, March-April, 2003, pgs. 60-67
- “Enter the Lavi,” *Defense Update*, Number 76, pgs. 2-13
- “Firepower in Sinai,” *Ordnance*, November-December, 1968, pgs. 273-277
- “Focus on Israel,” *Military Technology*, Number 2, 1987, pgs. 93-119
- “From Brigade to Division,” *Military Review*, October, 1978, pgs. 64-71
- “From Kfir to Lavi,” *Defense Update*, Number 55, pages 4-64
- “Golan, the Air War,” *Born in Battle*, Number 15, 1980, pgs. 50-64
- “Grumman M161 – Israel’s Combat Hydrofoil,” *Defense Attache*, Number 5, 1981, pgs. 11-22
- “Have Nap Offers Stand Off Capability for B-52s in Mideast,” *Aviation Week*, September 3, 1990, pg. 35
- “History of the Israeli Navy 1948,” *Defense Update*, Number 51, pgs. 2-9
- “IAF Gloster Meteor,” *IAF Aircraft Series*, Number 7, pgs. 2-40
- “IDF 1987,” *Defense Update*, Number 83, pgs. 36-43
- “IDF Armour Today,” *Defense Update*, Number 92, pgs. 51-58

- “Incorporating Attack Helicopters Into IDF Defense Doctrine,” *IDF Journal*, Spring, 1987, pgs. 23-26
- “Israel Air Force,” *Air Forces Monthly*, August, 2004, pgs. 54-65
- “Israel Boosting Sensor and Interceptor Capabilities,” *Aviation Week*, October 4, 2010, pgs. 58-60
- “Israel County Briefing,” *Jane’s Defense Weekly*, November 17, 2004, pgs. 19-28
- “Israel Defense Portrait,” *Military Technology*, Volume 4, 1980, pgs. 26-51
- “Israel to Boost Combat Aircraft Strength,” *Aviation Week*, February 14, 1983, pg. 17
- “Israel; in Peace but,” *Military Technology*, Volume IV, Number 20, pgs. 26-51
- “Israel’s Advances in Weapons and Precision,” *Aviation Week*, January 18-31, 2016, pgs. 41-45
- “Israel’s Aerospace Industry,” *Military Technology*, Number 6, 2001, pgs. 70-83
- “Israel’s Armor in Action,” *Born in Battle*, Number 4, pgs. 1-80
- “Israel’s Brave New World,” *Aviation Week*, September 6, 2010, pgs. 26-27
- “Israel’s Combat Helicopters,” *Defense Update*, Number 67, pgs. 8-11
- “Israel’s Defense Doctrine,” *Defense Update International*, Number 50, pgs. 8-16
- “Israel’s Defense in the 1980s,” *Defense Attache*, Number 4, 1980, pgs. 35-44
- “Israel’s Defense,” *Aviation Week*, December 17, 2007, pgs. 48-55
- “Israel’s Expanding Capabilities,” *Defense Attache*, Number 1, 1981, pgs. 35-54
- “Israel’s Halftracks,” *Military Enthusiast*, Volume 3, Number 12, pgs. 24-36
- “Israel’s New Merkava,” *War Data*, Number 10, pgs. 2-48
- “Israel’s Police and Security Equipment,” *Military Technology*, Number 11, 2001, pgs. 69-75
- “Israel’s Recce Phantoms,” *Air Forces Monthly*, Number 166, pgs. 28-31
- “Israel’s Response to the Ballistic Missile Threat,” *Military Technology*, Number 3, 2000, pgs. 30-36
- “Israel’s Unmanned Systems,” *Aviation Week*, August 23, 2010, pgs. 64-67

- “Israeli AF/DF Profile,” *Combat Aircraft*, January, 2005, pgs. 36-41
- “Israeli Defense Developments,” *Aviation Week*, November 1, 2010, pgs. 94-99
- “Israeli Defense Industry,” *Jane’s Defense Weekly*, February, 2003, pgs. 14-25
- “Israeli Defense of the Golan,” *Military Review*, October, 1979, pgs. 2-13
- “Israeli Defense Plans,” *Aviation Week*, April 10, 2000, pgs. 62-73
- “Israeli Defense,” *Aviation Week*, August 9, 2010, pgs. 42-47
- “Israeli Defense,” *Aviation Week*, June 24, 2002, pgs. 78-93
- “Israeli F-16s – Latest Developments,” *Air Forces Monthly*, Number 195, pgs. 36-39
- “Israeli Navy Submarines,” *Defense Update*, 1985, pgs. 20-25
- “Israeli Night Owls,” *Air Forces Monthly*, November, 2002, pgs. 54-57
- “Israeli Reconnaissance,” *Aviation Week*, September 4, 2000, pgs. 70-73
- “Israeli Reds,” *Air Forces Monthly*, September, 2010, pgs. 44-45
- “Israeli Thunders,” *Air Forces Monthly*, February, 2003, pgs. 52-57
- “Israeli Transports,” *Air Forces Monthly*, September, 2005, pgs. 42-47
- “Israeli Vipers in Action,” *Air Forces Monthly*, August, 2002, pgs. 80-83
- “Kurnass 2000,” *Air Forces Monthly*, Number 13, pgs. 60-61
- “Lasing the Israeli Way,” *Air Forces Monthly*, February, 2002, pgs. 40-41
- “Last of the Fighting Wooden Wonders,” *Air Enthusiast*, September-October, 1999.
pgs. 30-51
- “Lavi or the Alternatives,” *Born in Battle*, Number 79, pgs. 30-35
- “Lessons of Lebanon,” *Defense Attache*, Number 4, 1982, pgs. 23-36
- “M-48/60 Patton,” *War Data*, Number 4, pgs. 43-47
- “Magach 7,” *Defense Update*, Number 97, pgs. 38-41
- “Magic Touch Pythons,” *Air Forces Monthly*, November, 2003, pgs. 50-53
- “Merkava – A National Enterprise,” *IDF Journal*, May, 1984, pgs. 46-63

- “Merkava II,” *Defense Update*, December, 1986, pgs. 2-11
- “Merkava,” *Military Technology*, July, 1981, pgs. 105-112
- “Middle East Conflict,” *Aviation Week*, October 22, 2012, pgs. 48-62
- “Missile Boat Warfare,” *IDF Journal*, Fall, 1986, pgs. 37-43
- “Modern Inter-Arms Concepts, IDF Organization in the Yom Kippur War and After,” *Defense Update*, Number 69, pgs. 32-43
- “Modern Inter-Arms Concepts,” *Defense Update*, Number 67, pgs. 49-59
- “National Security,” *IDF Journal*, August, 1983, pgs. 37-43
- “Nevatim Wakes Up,” *Air Force Monthly*, June, 2003, pgs. 58-59
- “New Developments in Israel’s Land Forces Equipment,” *Military Technology*, Number 6, 2002, pgs. 112-163
- “New Intelligence on Merkava Mk. 2 and 3,” *Defense & Armament*, June, 1986, pgs. 32-33
- “New Life for the T-55,” *Defense Update*, 1985, pgs. 26-34
- “Offense and Defense in Israel’s Military Doctrine,” *IDF Journal*, Summer, 1990, pgs. 6-11
- “Ovda – Jewel of the Desert,” *Air Forces Monthly*, number 163, pgs. 40-41
- “Peace Jack Phantoms,” *Air Forces Monthly*, November, 2004, pgs. 68-75
- “Phantom 2000 for the IAF,” *Defense Update*, Number 81, pgs. 50-61
- “Putting Steel on Target,” *International Defense Review*, Number 12, 1986, pgs. 1823-1832
- “Ramon, Israel,” *Air Forces Monthly*, June, 2000, pgs. 80-82
- “Satellite Imagery for All,” *Military Technology*, Number 7, 2002, pgs. 46-49
- “Shafir II,” *Air Forces Monthly*, October, 2000, pgs. 70-72
- “Sherman,” *War Data*, Number 6, pgs. 21-48
- “Simulators and Trainers in the Ground Forces,” *IDF Journal*, Spring 1986, pgs. 48-53
- “Stars of Israel,” *Combat Aircraft*, November, 2005, pgs. 22-27

- “Suez Combat,” *Air Forces Monthly*, October, 1999, pgs. 52-57
- “Swept Wing Background,” *Air Enthusiast*, March-April, 2005, pgs. 12-25
- “Tank Upgrading in the IDF,” *Defense Update*, Number 74, August, 1986, pgs. 13-25
- “Tank Upgrading,” *Defense Update*, Number 36, pgs. 4-12
- “The Air Defense Forces and Israeli Technology,” *IDF Journal*, May, 1985, pgs. 29-34
- “The Air War in the Mid East,” *Born in Battle*, Number 2, pgs. 1-79
- “The Evolution of the Ground Corps Command,” *IDF Journal*, Summer, 1986, pgs. 8-15
- “The Future of Israeli Air Power,” *Flight International*, June 24, 1988, pgs. 1-18
- “The Gunner’s Dream,” *Defense Update*, Number 66, pgs. 34-46
- “The IDF in 86,” *IDF Journal*, Spring, 1986, pgs. 6-8
- “The Israel Ground Force Industry,” *Military Technology*, Number 6, 2000, pgs. 149-174
- “The Israeli F-16 Story,” *F-16 Fight Falcon*, pgs. 60-65
- “The Main Battle Tanks of the Yom Kippur War,” *Conflict*, pgs. 3-27
- “The Sinai Campaign – Thirty Years Later,” *IDF Journal*, Winter, 1987, pgs. 54-63
- “The Six Day War,” *Born in Battle*, Number 6, pgs. 2-80
- “The State of Israel,” *Defense & Diplomacy*, October, 1989, pgs. 56-67
- “The Suez Crossing,” *Military Review*, November, 1979, pgs. 2-7
- “The War of Atonement,” *Battle*, Number 1, pgs. 9-27
- “The Wild Horses, IAF Mustang Squadron,” *Born in Battle*, Number 17, 1981, pgs. 33-49
- “The Yom Kippur War,” *Born in Battle*, pgs. 1-84
- “Thirty Years After the October 1973 War,” *Air Forces Monthly*, December, 2003, pgs. 34-41
- “Trainers in Combat,” *Air Enthusiast*, July-August, 2001, pgs. 42-55
- “Tsahal’s Puma Combat Engineer Vehicle,” *Raids*, May, 1994, pgs. 20-23
- “Turtles and the Cheetahs,” *Air Enthusiast*, March-April, 2001, pgs. 44-49

“Updating Israeli Military Doctrine,” *IDF Journal*, Winter, 1991, pgs. 32-35

“World Air Forces 2002,” *Flight International*, November 26, 2002, pgs. 33-78

“World Defense Almanac,” *Military Technology*, Number 1, 1988, pgs. 248-250

“World Defense Almanac,” *Military Technology*, Number 1, 1995, pgs. 217-219

“World Defense Almanac,” *Military Technology*, Number 1, 2002, pgs. 238-246

“World Military Aircraft Summary,” *Aviation Week*, January 14, 2002, pg. 270

“Yom Kippur War,” *War in Peace*, Volume 7, Number 80, pgs. 1589-1602

Recent BESA Center Publications

Mideast Security and Policy Studies

- No. 130 The Kurds in a Volatile Middle East, *Ofra Bengio*, February 2017
- No. 131 Qatar: The Limits of Nouveau Riche Diplomacy, *Gil Feiler and Hayim Zeev*, April 2017
- No. 132 Are Lone Wolves Really Acting Alone? The Wave of Terror 2015- 2008, *Shaul Bartal and Hillel Frisch*, May 2017 (Hebrew) - online only
- No. 133 Saudi Arabia, the Gulf, and the New Regional Landscape, *Joshua Teitelbaum, ed.*, May 2017
- No. 134 Rethinking the Six-Day War, *Efraim Karsh, Gabriel Glickman, and Efraim Inbar*, June 2017
- No. 135 Washington and Moscow: Confrontation or Cooperation? *Jiri Valenta and Leni Friedman Valenta*, June 2017
- No. 136 Foreign Investment in Israel's Strategic Industries, *Efraim Chalamish*, July 2017
- No. 137 A Dense Triangle: Israel, Hamas-Gaza and the Palestinian Authority, *Hillel Frisch*, August 2017 (Hebrew)
- No. 138 The Low-Profile War Between Israel and Hezbollah, *Yaakov Lappin*, August 2017
- No. 139 Greece, Israel, and China's "Belt and Road" Initiative, *George Tzogopoulos*, October 2017
- No. 140 Arabs and Turks Welcomed the Balfour Declaration, *Efraim Karsh*, November 2017
- No. 141 Schoolbooks of the Palestinian Authority (PA): The Attitude to the Jews, to Israel and to Peace, *Arnon Groiss and Ronni Shaked Arnon Groiss*, December 2017 (Hebrew)
- No. 142 Conflicting Interests: Tehran and the National Aspirations of the Iraqi Kurds, *Doron Itzhakov*, December 2017
- No. 143 Russia's Strategic Advantage in the Baltics: A Challenge to NATO? *Jiri Valenta and Leni Friedman Valenta*, January 2018
- No. 144 Surviving Donald Trump: Israel's Strategic Options, *Louis René Beres*, February 2018
- No. 145 Militant Islam's War Against the West, *Max Singer*, March 2018
- No. 146 Reframing the Middle Eastern and Palestinian Refugee Crises, *Alex Joffe and Asaf Romirowsky*, March 2018
- No. 147 Water, Trump, and Israel's National Security, *Donald D.A. Schaefer*, March 2018
- No. 148 Sudan's Policy in the Era of Arab Upheaval: For Good or for Evil? *Haim Koren*, April 2018
- No. 149 The Privileged Palestinian Refugees, *Efraim Karsh*, May 2018
- No. 150 The Israel Defense Forces, 2017-1948, *Kenneth S. Brower*, May 2018

Policy Memoranda

- No. 7 The Gaza War, 2014 – Initial Assessment, *Efraim Inbar and Amir Rapaport*, December 2014 (Hebrew)
- No. 8 Perfect Storm in the Middle East, *Yaakov Amidror*, June 2015 (Hebrew), July 2015 (English)
- No. 9 Israel-Greece Relations, *Arye Mekel*, September 2015 (Hebrew)
- No. 10 Space Wars, *Aby Har-Even*, May 2016 (Hebrew)

Colloquia on Strategy and Diplomacy

- No. 28 The IDF Force Structure (Hebrew) May 2014
- No. 29 Israeli-Palestinian Negotiations: Where to? (Hebrew) August 2014
- No. 30 IDF Challenges (Hebrew) August 2016