Chapter 19

REST OF WORLD MISSILE SYSTEMS

The ballistic missile threat posed to the U.S. from the Soviet Union during the 1950s-1960s necessitated the development of U.S. missile launch warning systems. By the 1970s, the first satellites of the Defense Support Program (DSP) were launched and placed into geo-stationary orbits to detect hostile ballistic missiles. This chapter will review the missile threat capability of the Former Soviet Union (FSU) as well as other ROW nations, focusing on those ballistic missiles which can be detected by U.S. space-based sensors.

RUSSIAN MISSILE SYSTEMS

When the Soviet Union broke up in the early 1990's, the result was four nations versus one with nuclear ballistic missiles; Russia, Ukraine, Belarus and Kazakhstan. However, by early 1997, only Russia retained a strategic nuclear missile force; the other three countries having shipped their warheads back to Russia. The Russian strategic capability revolves around a triad of Submarine Launched Ballistic Missiles (SLBMs), land-based Inter-continental Ballistic Missiles (ICBMs) as well as land-attack cruise missiles (CMs) carried on strategic bombers and nuclear attack submarines.

Despite the reductions of the Strategic Arms Reduction Treaties (START I/II), the Russian strategic offensive force will retain approximately 50 percent of its firepower deployed on land-based ICBMs. Also, these ICBMs will continue to fulfill the most important targeting require-meanest in any strategic nuclear strike.

Fourth Generation ICBMs

The Fourth Generation Soviet ICBMs, consisting of the SS-18 and SS-19, were introduced into the operational inventory in the late 1970s. This generation of missiles gave the FSU a modernized and sophisticated force.

For the first time, the FSU deployed Multiple Independently Targetable Reentry Vehicles (MIRV) technology. A MIRV-capable system can carry a number of warheads and strike different targets using just one missile. Equally important, the accuracy of these missiles gave them the capability to strike hardened targets such as U.S. ICBM silos. Additionally, the introduction of cold-launch technology gave the FSU the capability to re-launch from the same silo. The cold-launch system consists of a gas generator located at the bottom of the silo which ejects the missile out of the silo. Once clear from the silo, the main engine of the missile ignites, thus minimizing damage to the launch facility.

SS-18 (SATAN) Weapon System

The SS-18 (**Fig. 19-1**) is the centerpiece of the Russian Strategic Missile Force and of the Fourth Generation ICBM force. This system was designed to target hardened Minuteman missile silos. The SS-18, which is larger than the U.S. Peacekeeper, has been modernized many times over the life of the program. Silo (**Fig. 19-2**) conversion activity has replaced some of the older SS-18 force with the MOD 5 MIRV and the single RV MOD 6.

Fig. 19-1. SS-18

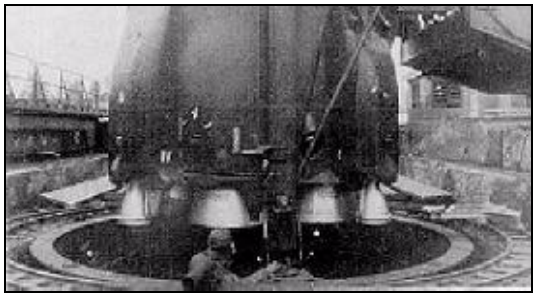

Fig. 19-2. SS-18 Silo loading

These upgrades temporarily offset the firepower losses required under the START I. START I reduces the number of allowed SS-18 to 154 and START II requires the elimination of all SS-18s by January 2003. START II also eliminates all land-based MIRV'd missiles by 2003.

SS-19 (STILLETO) Weapon System

The SS-19 is the third of the Fourth Generation ballistic missiles developed by the FSU. Unlike the SS-17 and SS-18, this missile is hot-launched from its silo. Under a special provision of START II, Russia is allowed to keep 105 single warhead versions of the SS-19.

In December 1994, the launch of an SS-19 was reported as a trial to determine the suitability of use as a civilian satellite launcher, called ROCKOT. On May 16, 2000, Russia announced the successful Commercial Demonstration Flight (CDF) of their ROCKOT launch vehicle from the Plesetsk Cosmodrome. The goal of the CDF was the commissioning of the ROCKOT as an operational launch vehicle as well as the qualification of the dedicated EUROCKOT launch facilities at Plesetsk.

Fifth Generation ICBMs

The Fifth Generation of ICBMs, introduced in the 1980s, was the result of new force objectives. During the 1970s, with the Fourth Generation of ICBMs, the Soviets acquired tremendous technological advances that gave them better accuracy (hard-target capability), MIRV technology (more targets with one missile) and a cold-launch (reload/refire) capability. However, FSU strategic planners realized that their land-based ICBM force was still threatened by a pre-emptive strike from the U.S. With this in mind, they concentrated their efforts in creating a more survivable force. The introduction of the SS-24 and SS-25 in the mid-1980s highlights the FSU's success with mobile systems (to be completely accurate, their success with mobile systems began with the deployment of the SS-20 IRBM in 1977). Furthermore, the incorporation of these systems has enhanced the survivability of the ICBM force and assures the Russians that their requirements for responsiveness and accuracy will be met. By the year 2000, the mobile ICBM segment of the inventory could account for about one third of the Russian force.

SS-24 (SCALPEL) Weapon System

The SS-24 is a solid propellant MIRV system that can be targeted against soft and semi-hardened targets. This missile has been deployed in two different modes, rail-mobile and in retrofitted SS-19 silos. The SS-24 MOD 1, a rail mobile system, was first deployed in 1987 and it is currently deployed at three launch garrisons. SS-24 missile trains reportedly have three missile launch cars, several locomotives, a power generator car, a command car, and several support cars. The rail garrisons are assessed to contain four trains each and are capable of deploying on the 145,000 km railroad system. Alert duties were cut back drastically in 1994, due to costs and security concerns.

All silo based SS-24 MOD 2s have been decommissioned. In accordance with START-II, the SS-24, rail as well as silo versions, will be phased-out and destroyed.

SS-25 (SICKLE) Mobile ICBM System

The SS-25 joined the operational inventory in 1985. This system is a road-mobile, single warhead, three-stage solid-propellant missile, comparable in size to the U.S. Minuteman ICBM. The SS-25 is carried on a seven axle-wheeled, Transporter Erector Launcher (TEL) (**Fig. 19-3**). This weapon system gives Russia a highly survivable ICBM with an

Fig. 19-3. SS-25 TEL

inherent refire capability. The garrison bases that house this system consist of garages equipped with sliding roofs for the TEL and other support buildings for critical mobile equipment (such as generators and command/control vehicles).

Production of the SS-25 has ended as this missile will be replaced by the newer SS-27. The mobile missile garrisons are constrained by START I which stipulated that in peace time, mobile units will be confined in a 25 square kilometer area around their garrison. Russia has also developed mobile satellite launchers from the SS-25 boosters, which are called "Start 1" launch vehicles after the treaty.

SS-27 *Weapons System*

The SS-27 is an evolutionary upgrade of the SS-25. This new system is a cold-launched, three stage, solid propellant ICBM that will be deployed in both silo-based and mobile versions (**Fig. 19-4**).

Development of the SS-27 began in the late 1980's with the first test launch in December 1994. Initial deployment of the silo-based version began in 1998.

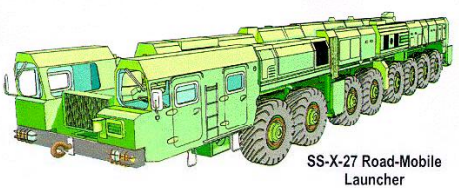

Fig. 19-4. SS-27 TEL

The road-mobile version will be fielded sometime in the near future.

Previously, in the former Soviet Union, most ICBM systems were built in the Ukraine. The SS-27 was designed so that it could be totally manufactured in Russia.

Among the Russian stated system improvements are anti-ballistic missile features and a space navigation system.

Submarine Launched Ballistic Missile Systems (SLBMs)

Russia currently has three primary SLBM platforms: the Delta III, Delta IV and the Typhoon class submarines. These nuclear powered ballistic missile submarines, referred to as SSBNs, are based on the Kola Peninsula in northern Russia and on the Kamchatka Peninsula in the Russian Far East.

Current Russian doctrine dictates that ballistic missile submarines should deploy in waters close to Russian landmass, since these patrol areas (known as bastions) can be protected by aircraft, sonar networks, surface ships and Russian attack submarines. Additionally, it should be noted that the Russian SSBN force is capable of striking most of the CONUS from pier-side, reducing the need to deploy well away from Russian shores.

Delta III/SS-N-18 (STINGRAY)

The Delta III carries the two-stage SS-N-18, the first MIRV'd Soviet SLBM. This submarine carries 16 missiles, each with three MIRV warheads.

Following implementation of START I and II, it is expected that some of the SS-N-18s will be withdrawn from service. There remain questions regarding the future size of the Russian SSBN force. A revised Russian plan suggests that the entire Delta III class may be retired in the next decade.

Delta IV/SS-N-23 (SKIFF)

A three-stage liquid-propellant SLBM was tested in 1983 from a submarine designated the Delta IV. This SLBM was designated as the SS-N-23 and is more accurate than the SS-N-18. The SS-N-23 is about 47 feet long, carries up to 10 MIRVs and has a range of 4,500 nm.

All seven Delta IV submarines (**Fig. 19-5**) are based on the Kola Peninsula, with protected bastion patrol areas in the nearby Barents Sea and easy access to the Arctic.

Fig. 19-5. Delta IV with missile hatch open

Even though the SS-N-23 has the capability to carry 10 MIRVs, it is counted as carrying four MIRVs under the START agreements. Four is the number of warheads per missile postulated for future deployment.

Typhoon/SS-N-20 (STURGEON)

The SS-N-20 SLBM was first identified in the early 1980s. The missile test program was unsuccessful during its early stages. However, following the first Typhoon submarine launch in September 1980, subsequent successful missile tests from the submarine moved the program ahead. The Typhoon's SS-N-20 weapon system was declared operational by Western sources in 1984.

The SS-N-20 is a three stage, solid-propellant missile capable of carrying between 8 to 10 RVs, with a maximum range of approximately 4,300 nm. This range gives it the capability to operate within Russian waters and still strike targets on the North American continent.

The Typhoon is the largest operational SSBN in the world. This submarine is approximately one third larger than the U.S. Ohio Class SSBN. It is estimated to have been designed to conduct missile patrols under the Arctic Ocean ice cap. Six Typhoons are estimated to be operational, each with 20 launch tubes and a total weapon capacity of 120 SS-N-20 missiles carrying 960 warheads.

A unique feature of the Typhoon is that its missile bays are located forward of the submarine's sail. All other Russian and U.S. SSBNs have their missile bay behind the sub's sail (**Fig. 19-6**).

Fig. 19-6. Typhoon-class SSBN

Borei/SS-NX-28 and Bulava-30

Reports in the early 1990's indicated that a follow-on to the SS-N-20 was being developed, the SS-NX-28. Little is known about this system, however there have been reports of numerous difficulties with the system. There have been four test launches of the SS-NX-28, the latest in November 1997. None of the launches have been successful. Like the ICBM's, much of the former Soviet SLBM systems were build in the

Ukraine, so Russia has had difficulties in building such missile systems.

A new class of SSBN was envisioned for this new missile system, the Borei. The first of these fourth generation submarines was started in 1996 but lack of funding and the SS-NX-28 problems has significantly delayed construction. Both the SS-NX-28 and Borei programs have been cancelled due to technological and economic roadblocks. Russia has announced a replacement system called the Bulava-30. A new SSBN, called the "Dolgoruky" will carry the new missile, which has a range of 8,000+ km.

Cruise Missile Systems

Russia recognizes the advantages of having a cruise missile force as part of their strategic offensive capability. Equally important, they recognize the defensive challenges inherent with these systems. With this in mind, Russian military designers and planners have pursued their own cruise missile program.

Platforms have been developed for deployment in air and on sea. Two such systems have been named by the U.S. and the North Atlantic Treaty Organization (NATO) as the AS-15 (KENT) and the SS-N-21 (SAMPSON). These systems have common characteristics, such as a small airframe, low flight profile, subsonic speed and a possible nuclear warhead. Such characteristics provide these systems with an excellent probability of penetrating defenses and successfully accomplishing their mission. These weapons systems and their related carriers cannot be detected from space under normal operating conditions.

AS-15 (KENT)

The AS-15 is a small, subsonic cruise missile capable of delivering a nuclear warhead to a maximum distance of approximately 1850 nm. This weapon system resembles the U.S. Tomahawk cruise missile.

The AS-15 is thought to be equipped

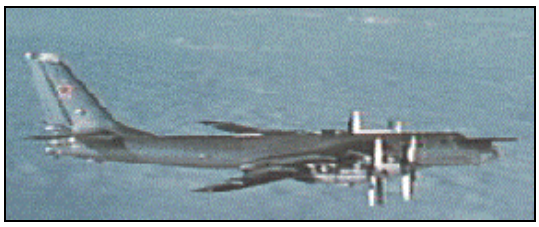

Fig. 19-7. TU-95 Bear

with a guidance system similar to our Terrain Contour Matching (TERCOM)

Fig. 19-8. TU-160 Blackjack

system. TERCOM guidance allows the system to correct any guidance errors that may occur during flight. The AS-15 is carried by the TU-95 Bear H (**Fig. 19-7**) and the TU-160 Blackjack bombers (**Fig. 19-8**).

SS-N-21 (SAMPSON)

The SS-N-21 Submarine Launched Cruise Missile (SLCM) is believed to have about the same characteristics as that of the AS-15. However, this system presents a unique detection problem. With the AS-15, we know what Russian aircraft are configured to support Air Launched Cruise Missile (ALCM) employment. However, the SS-N-21 was developed to fit in a standard Russian 53cm torpedo tube. From a detection standpoint, it will be difficult to determine when a Russian submarine is carrying SLCMs or standard torpedoes, since no externally apparent modifications are required. The SS-N-21

may be carried on the Akula fast attack submarine (**Fig. 19-9**), which is one of the quietest submarines in the world.

Fig. 19-9. Akula-class submarine

The Russian SLCM force could represent a significant threat against U.S./ European targets. Because of their unique flight profiles, SLCMs have the potential of being used as a surprise/first strike option against U.S. and allied airfields.

Theater Ballistic Missile Systems

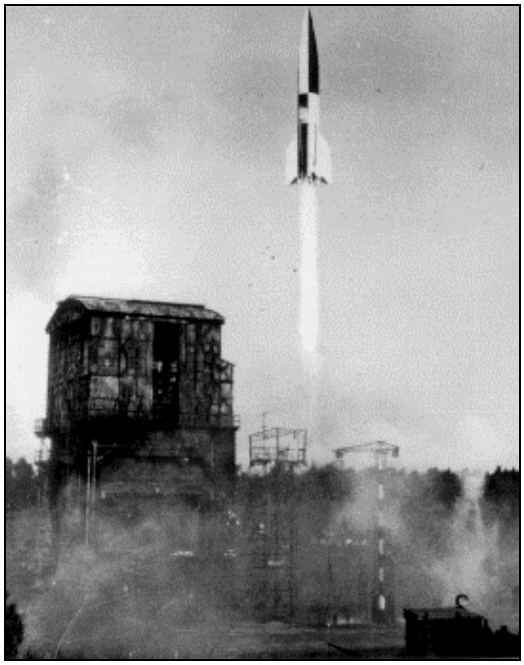

Fig. 19-10. German V-2 test launch

Also referred to as Tactical Missile systems, these missiles have ranges of up to 1,000 km. This type of missile was the first type of missile developed. During World War II, the Germans developed the first ballistic missile, the V-2 (**Fig. 19-10**). These primitive missiles had a range of 200 to 220 miles and carried a 730 kilogram high explosive warhead. In all, more than 3,000 V-2s were launched in the final months of World War II.

After the defeat of Germany, V-2 rockets, technology and specialists were taken to both the U.S. and Russia. Using this German technology and knowledge, both the U.S. and Russia began to develop their respective missile and space programs.

In Russia, work on the SS-1 series began in 1945, when Russia decided to build two versions of the V-2. Two groups worked on creating derivatives of the V-2: one group consisted of Germans captured after the war, the other was made up of Russians. Both team's missiles were successfully tested in 1948. The Russian built version was selected for development. From this first SS-1A missile, further development led to the SS-2 on through the SS-5. Versions of the SS-4/5 became the space boosters SLV-7/8, referred to as "Kosmos". Technology developed in these programs led to the development of the SS-6. As a space booster, versions of the SS-6 are still used today as the SLV-4 "Soyuz" and SLV-6 "Molniya".

SS-1 Series (SCUD)

Further development of tactical missiles led to the SS-1C, more commonly known as the SCUD-B. This weapon entered service in 1962 and in 1965 a wheeled MAZ transporter-erector-launcher (TEL) was introduced (**Fig. 19-11).**

Used by the Russian Army, the SCUD-B was also exported to various other nations. From this exportation, the current proliferation of theater ballistic missiles began, as countries resold, reverse engineered and developed the technology to initiate their own missile programs.

One of the newest developments to the SCUD missile has been the Aerofon version. This system improvement has centered on warhead improvements.

Fig. 19-11. SS-1C, SCUD-B

Unlike the earlier models, the SCUD Aerofon is reported to have its warhead separate from the engine and fuel tank assembly after engine burnout. This is done to increase the stability and accuracy of the warhead. In addition, an optical correlation device was added for digital scene matching in order to refine the aim point as the missile approaches the target area. The goal of this appears to be to increase missile accuracy to around 50 meters.

PEOPLES REPUBLIC OF CHINA (PRC) MISSILES SYSTEMS

The Peoples Republic of China is the only other non-western nation with a known strategic nuclear and missile capability. China's missile capabilities span all ranges and payloads, from tactical to intercontinental. Since their entry into the export market in the 1980s, they have actively aided several countries in missile development programs

Strategic Missile Systems

China's missile program started in the mid-1950s with help from the Soviet Union. A number of SS-2 missiles, improved adaptations of the V-2, were supplied to China. Additionally, some SS-2's were locally produced under license and designated DF-1 (Dong Feng - East Wind) by the Chinese. The first test flight of a DF-1 took place in November 1960. It appears the Chinese also had access to the Russian SS-3.

After the break with Moscow in the early 1960s, China used its existing industrial base to build its first indigenous missile, which appeared to combine aspects of the SS-2 and SS-3. This system was called the CSS-1 by the West and the DF-2 by China. One of the main shortcoming of the CSS-1 was the use of liquid oxygen for fuel. The missile could not be stored fully fueled for long periods nor launched on short notice. Recognizing this, the Chinese

Fig. 19-12. CSS-2/DF-3

started the development of a series of missiles using only storable propellants.

CSS-2/DF-3

The CSS-2 (**Fig. 19-12**) was the first truly indigenous Chinese ballistic missile. Deployed in 1971 the CSS-2 is a single stage, liquid-fueled system with a payload of 2,200 kilograms carrying one nuclear warhead in the megaton class. With a range of 2,500 km, the CSS-2 had sufficient range to attack the former U.S. bases in the Philippines.

An improved version, DF-3A, entered service in 1986 with an increased range of 3,800 km.

Despite its age, the CSS-2 may be the largest element of the PRC's nuclear force. At least 50 missiles are thought to be currently deployed. The system is believed to be transportable, with basing at permanent sites in northwest China from which targets in central and eastern Asia could be reached. (**Fig. 19-13**).

Fig. 19-13. CSS-2 Missile Convoy

Fig. 19-14. CSS-3 on parade

In 1988, China sold conventionally armed CSS-2s to Saudi Arabia as part of a multi-billion dollar deal, heightening proliferation concerns in the Middle East.

CSS-3/DF-4

The two stage CSS-3 (**Fig. 19-14**) was designed essentially in parallel with the CSS-2. It was considered a stop-gap measure until the longer range DF-5 (CSS-4), a true ICBM, could be developed. The CSS-3 incorporated essential components, including the entire 1st stage of the subsequent CSS-4. A civil version of the CSS-3 was also developed, the Long March I, China's first space launch vehicle.

Originally designed to reach the U.S. bases in Guam, the CSS-3's range capability was increased after the deterioration in relations between Russia and China. The enhanced missile was designed to strike Russian cities, in particular, Moscow.

The system is believed to have become operational in 1980 and received upgrades to improve accuracy in 1985. Main deployment for this system is in western China, an area from which targets in Russia are accessible. Between 20 and 30 missiles are thought to be deployed, primarily in caves. The missiles are prepared for launch while inside the caves then moved outside just prior to launch.

Fig. 19-15. LM-2C, CSS-4

CSS-4/DF-5

The CSS-4 is currently China's only true ICBM. The missile was designed to have a range of 12,000 km in order to attack the U.S., Russia and other parts of Asia. Research started in

1965 with the first test flights in 1979 and 1980.

The civilian version, Long March 2C (**Fig. 19-15**), is used for space launches. This launcher has been operational since 1975, some five years before the ICBM version was completed.

In 1983, improve-ments to the missile lead to the DF-5A with an increased range to 13,000 km and improved payload capacity to 3,200 kilograms. Currently, this is the only Chinese missile that can be silo launched.

Only a small number of CSS-4 missiles have been deployed, possibly to demonstrate that China could deploy a superpower-type silo-based ICBM if needed. The limited deployment might also have been planned so as not to cause major fears and reactions among the other nuclear powers and adhere to China's declared "minimum deterrence doctrine".

CSS-5/DF-21

The CSS-5 is a road mobile, two-stage solid propellant intermediate-range missile. It was derived from the sea-based CSS-N-3/JL-1 SLBM.

The development of the JL-1 began in the mid-1960s. The first test launch of the JL-1 was in 1982, while the CSS-5 was first flown in 1985. These two versions are China's first solid propellant ballistic missiles.

In 1987, the CSS-5 became the first truly mobile Chinese missile system. The system is mounted on a tractor-trailer type Transporter-Erector-Launcher, or TEL **(Fig. 19-16)**. The missile uses a cold launch technique where the missile is ejected from a container and the engines ignite while airborne. The Chinese Army uses a six-vehicle convoy to deploy the CSS-5 system.

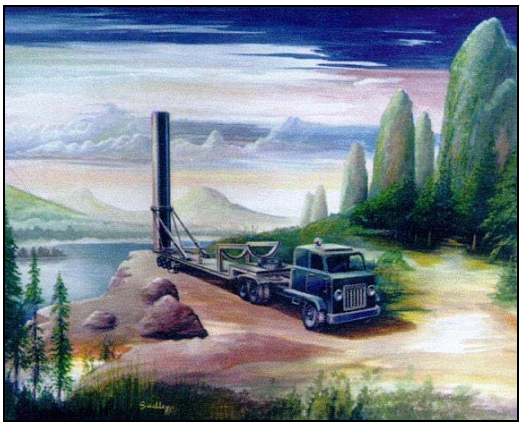

Fig. 19-16. CSS-5 TEL

Reportedly, there is a DF-21A variant. Reported improvements include range increase from 2,150 km to 2,500 km, improved accuracy through satellite navigation (GPS or the Russian GLONASS), a radar-based terminal guidance system and warhead improvements.

The CSS-5 is designated as a replacement tactical nuclear missile for the liquid-fueled CSS-1.

DF-31

The DF-31 is China's first solid-fuel ICBM. First tested in August, 1991, this three stage missile has a range of 8,000km. It is launched from a mobile TEL and carries a single nuclear warhead.

Chinese SLBMs

China currently has only one SLBM class vessel, the "Xia". The development of SLBMs and submarines to carry them has been a long process for China. The first operational Chinese ballistic missile submarine was a conventional-powered Golf II assembled from Soviet parts in 1964. The Golf tested the first Chinese SLBM and has since been used for training and a test vessel for missile crews. The Golf II can carry two missiles in the sail. Given time, the Golf

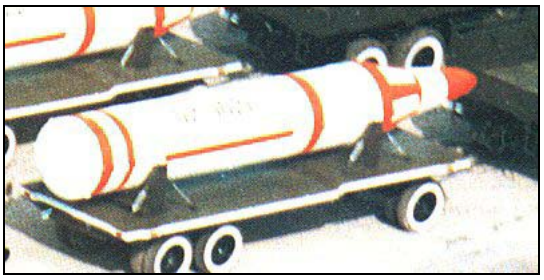

Fig. 19-17. CSS-N-3 (JL-1) SLBM

could be outfitted in a crisis and deployed with operational weapons.

Xia (CSS-N-3/JL-1)

The CSS-N-3 (**Fig. 19-17**) was developed throughout the late 1970's, with the first test firing in 1982. Initial launches were from a submerged firing pontoon, and then from China's diesel powered Golf II submarine.

The missile took about 15 years to develop, primarily due to difficulties in using solid propellant (this was China's first missile not to use liquid fuel), problems with smaller warheads, problems with underwater launching and difficulties with the Xia class nuclear powered submarine itself.

Fig. 19-18. Xia class SSBN

The CSS-N-3 has such a short range, 1,700 km, that it is limited operationally. Chinese vessels would likely deploy in home waters where they can be protected by Chinese land and naval forces, similar to the Russian concept of SSBN bastion deployments.

The development of the Xia class SSBN (**Fig. 19-18**) has also been a long process. Its production was greatly delayed by difficulties in producing a safe and reliable nuclear reactor. As a result, the vessel was in development for twenty years. Its operational debut was in 1987. The JL-1 is known to have been launched twice from the Xia, once in 1988 and again in 1990.

The submarine carries 12 CSS-N-3 SLBMs. Operational deployment is unknown but it is believed that only two Xia have been built, however only one appears to be currently in service.

China is currently working on a replacement missile system. Following the success of the JL-1/CSS-5 joint development, the follow-on JL-2/DF-31 ICBM program appears to be following a similar development strategy.

In addition to a new missile system, China is designing and building a new class of SSBN for the JL-2 series missile.

Chinese Theater Ballistic Missiles

The Chinese M-series tactical short range ballistic missiles began development in the early 1980's. There are three versions: the M-7, M-9, and M-11.

M designations are used for the export versions while the Chinese versions have DF or other Chinese designations. These systems also carry a western CSS identification.

M-7/CSS-8

The M-7, Chinese project 8610, converted the HQ-2 surface to air missile (SAM) (itself a Chinese copy of the Russian SA-2 Guideline), into a surface-to-surface ballistic missile. The original booster and sustainer motors act as the first and second stages.

The missile has a range of 150 km with a 190 kilogram high explosive warhead. It is reported that the M-7 can

be launched from a tracked TEL adapted from the HQ-2 SAM launcher.

Fig. 19-19. M-9 missile

Fig. 19-20. M-9 TEL

Estimated to have entered service in 1992, this system was exported to Iran that same year.

M-9/CSS-6 DF-15

The M-9 (**Fig. 19-19**) was first flight tested in 1988 and in 1991 was operationally deployed. The M-9 is a solid fueled, single stage, road-mobile system (**Fig. 19-20**). It has a range of 600 km with a 500 kilogram high explosive warhead. Some reports indicate the
Chinese have a nuclear warhead option, believed to be around 90 kilotons.

Fig. 19-21. M-9 lifting out of its TEL

Initially assessed as a single stage system, recent reports suggest that there may be a separating warhead with its own miniature propulsion system. This may indicate some type of terminal guidance. The missile currently carries an inertial guidance package, although reports indicate the Chinese are working on upgrading in the future with GPS inputs.

The M-9 is deployed on an 8x8 wheeled TEL, with the missile raised to vertical before launch (**Fig. 19-21**). The system's solid fuel gives it a launch preparation time as short as 30 minutes. The system has been advertised for sale,

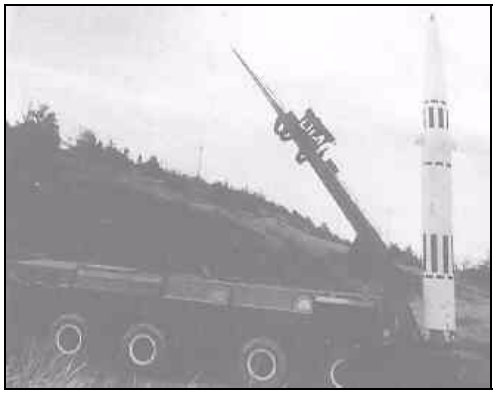

Fig. 19-22. M-11 model on TEL

with major selling points being its 30 minute reaction time and accuracy of under 600 meters.

M-11/CSS-7/DF-11

The M-11 (**Fig. 19-22**) was developed as a solid propellant, short range, road-mobile missile. Designed with external dimensions and electrical interfaces similar to the Russian SS-1C "SCUD-B"

missile, it is considerably shorter and lighter. As an interchangeable version of the SCUD-B, the M-11 is capable of being launched from a SCUD TEL with a minimum of modification.

The missile is stated to have a range of 300 km with a 500 kilogram warhead. First test flights occurred in 1990 and the missile is believed to have reached operational status in the late 1990s.

NORTH KOREAN MISSILE SYSTEMS

North Korea (the Democratic Peoples Republic of Korea) has been actively pursuing a ballistic missile development program since the mid-1970's. Initially they worked with the Chinese on a 600 km-range missile. Following the demise of this program due to internal problems in China, North Korea sought to obtain SCUD missile technology in order to provide the basis for an indigenous missile production capability. Purchase of foreign missile systems followed by reverse engineering and development of indigenous capabilities has created an active missile program.

Despite a severe shortage of resources, North Korea continues to press forward with its ballistic missile programs. North Korea is among the leading nations in the proliferation of missile systems, technology and manufacturing.

SCUD System

Around 1980, North Korea obtained a small number of Russian SCUD-B's from Egypt. The Koreans reverse-engineered the system and flight tested their copy, the SCUD Mod A, in 1984. While never intended to become a production model, it provided the basis for the North Korean SCUD Mod B; usually referred to as a SCUD-B, since it is nearly identical to the Russian version. This North Korean system incorporated several production engineering improvements.

SCUD-B

North Korean improvements to the Russian SCUD-B included slightly lighter structural materials and marginally more powerful engines, increasing the range from 300 to 320 km. Like the Russian missile, it possesses poor accuracy, with a circular error probability (CEP) of 500-1000 meters at maximum range.

With the SCUD-B, North Korea also began exports of ballistic missile systems to a number of nations. They established a relationship with Iran that has continued and financial aid obtained from Iran enabled full-scale SCUD production to begin in late 1986. Iranian financial assistance has been one of the most important factors in the success of North Korea's missile program. In return, Iran has received missile systems and limited production capabilities.

SCUD-C

Development of an extended-range SCUD missile began in 1987. This system, the SCUD-C, achieves a range of 550 km through the reduction in warhead weight to 500 kilogram and a slight increase in size and thus, propellant. The SCUD-C was first tested in June 1990. Like its predecessor, this system has also been exported to Iran, Egypt, and Syria.

In addition to the Russian MAZ TEL, North Korea has developed several TEL vehicles including German MAN and Japanese Nissan tractor trailer units.

NO-DONG System

North Korea pursued a twin-track approach in its efforts to develop longer range missiles. The first method led to the SCUD-C. However, there comes a point where neither increases in fuel nor lighter airframes will increase range without greater initial thrust and substantial redesign. In order to carry a larger warhead over a greater distance, a full redesign of the 1960's vintage SCUD

technology was needed. Thus, the development of the NO-DONG series was initiated by North Korea at roughly the same time as the SCUD-C program, but proceeded at a slower pace.

NODONG-1

An increase in thrust appears to have been achieved by using a cluster of four SCUD-B engines, much like the Russians did in their early SLBMs in the 1950's and the Chinese with the CSS-2. This increase in thrust is estimated to give the NO-DONG-1 a range of 1,000 km with a payload of 1,000 kilograms. The first test firing occurred in May 1993. Unlike the SCUD series, the NO-DONG warhead is believed to separate from the missile shortly before re-entry into the atmosphere.

The NO-DONG-1 is a road-mobile system. The TEL is a modified version of the Russian SCUD TEL vehicle.

Series production and deployment may have begun as early as 1996. When deployed operationally, the NO-DONGs 1,000 km range will place most of western Japan at risk.

As with the SCUD-B and C, North Korea appears to have sold the NO-DONG or its technology to various nations for their own missile programs. Pakistan and Iran appear to be the first nations to have developed missile systems based on NO-DONG-1 technology.

NODONG-2

North Korea may also be developing a 1,500 km version, the NO-DONG-2. Carrying the same 1,000 kilogram payload, the range increase may be achieved by making the main booster structure from an aluminum-magnesium alloy rather than steel. This could reduce the weight of the missile by at least one ton.

TAEPO-DONG Series

The TAEPO-DONG series consists of two systems, both with two stages. Such multi-staging represents a considerable advance for North Korea, requiring new materials and construction technologies.

TAEPO-DONG-1

The TAEPO-DONG-1 appears to use a NODONG-1 first stage and SCUD-derived second stage. This combination could give the missile a range of approximately 2,000 km with a 1,000 kilogram warhead.

On 31 August 1998, North Korea test launched the TAPEO-DONG-1 **(Fig. 19-23).** During this launch several new developments were revealed. The launch

Fig. 19-23 TAPEO-DONG-1

was claimed by North Korea to be a satellite launch and not a missile test. The system was launched in an easterly direction with the first stage landing in the Sea of Japan and, after overflying the Japanese islands, the second stage impacted in the Pacific Ocean 480 km east of the Japanese island of Honshu, some 1,500 km from its launch point.

One of the key surprise developments was the third stage. North Korea stated that this third stage was a solid fuel stage intended to place a satellite into orbit. This stage failed and the third stage along

with its satellite payload landed in the Pacific Ocean south of Alaska after a flight of about 6,000 km.

This test of a staging missile system put North Korea on a par with India as the only developing nation to master "staging".

TAEPO-DONG-2

The TAEPO-DONG-2 appears to have a new first stage and a modified NO-DONG-1 second stage. Initial estimates put the TAEPO-DONG-2 range at 4,000 km with a 1,000 kilogram payload. No flight tests of this variant have been noted.

While the TAEOPO-DONG systems appear to represent a considerable advance over the SCUD-based NO-DONG series, it is clear from looking back at China's missile development program, that these advances represent the next logical steps. Nonetheless, North Korea must overcome numerous additional technical obstacles if the TAEPO-DONG series is to become a viable operational system.

Fig. 19-24. Nike-Hercules SAM

SOUTH KOREAN MISSILE SYSTEMS

North Korean missile developments were likely the impetus for the initiation of South Korean missile programs. By reverse engineering U.S. supplied missiles, South Korea produced a two-stage, solid-fuel surface to surface missile based on the Nike-Hercules surface to air missile (**Fig. 19-24**). This development took place in the late 1970's.

NHK Series

NHK-1 and NHK-2 (Nike-Hercules-Korea) are in service with South Korean forces. The systems are reportedly capable of delivering a payload of about 450 kilograms to a range of roughly 260 km.

South Korea depends on the U. S. for most of its advanced weapons. An agreement between the U.S. and South Korea bans South Korea from developing medium/long-range missiles. However, in order to counter North Korea's theater ballistic missile development programs, South Korea has just completed negotiations with the US to allow for 300 km missiles.

INDIAN MISSILE SYSTEMS

India's security environment is dominated by the mutual distrust between themselves and Pakistan, with whom it has fought three wars since 1947 (47-48, 65, 71) and have near continuous border disputes. Another factor is its competition for regional influence with China, with whom it also fought a border war in 1962. A combination of high defense spending and considerable technical expertise has made India's military-industrial base one of the best in the third world.

Like many countries, India's missile developments have been closely related to their space program. Their efforts show what a determined, developing country can do with a long-term, measured approach to the concurrent development and production of space launch vehicles and missiles.

After failing to reverse-engineer a Russian SA-2 SAM as a viable Short Range Ballistic Missile (SRBM) in the 1970's, India started its Integrated Guided Missile Development Program (IGMDP) with the aim of achieving self-

sufficiency in missile production and development.

The IGMDP is comprised of five core systems. The first two are an SRBM and a Intermediate Range Ballistic Missile

Fig. 19-25. Prithvi SRBM

(IRBM) to be developed in close association with the space program. The other programs are a short and medium range SAM and an anti-tank guided missile.

Prithvi SRBM System

The Prithvi ("earth") SRBM missile design began in 1983 and was first test fired in 1988. This road-mobile, liquid fueled missile uses basic propulsion technology from the SA-2 SAM. Two versions of the Prithvi have been developed, the Prithvi-I and Prithvi-II, both believed to have entered service in 1994 or 1995.

The system is carried on a truck based eight-wheeled TEL (**Fig. 19-25**) and is raised to vertical for launch.

The Prithvi-I is an army version, having a range of 150 km carrying a 1,000 kilogram warhead, while the Air Force Prithvi-II has a range of 250 km with a 500 kilogram warhead.

The Prithvi class systems use a highly volatile liquid fuel and therefore, are fueled immediately prior to launch. Reports suggest that a solid propellant motor is being researched.

Fig. 19-26. Agni IRBM

A naval version of the Prithvi-II called the "Dhannsh" was test launched from an Indian naval vessel in 2000. The test was not successful but the Indian Navy will likely continue testing and eventually deploy the system.

Agni IRBM System

The Agni ("fire") missile represents a much more ambitious project than the Prithvi. First conceived in 1979, the Agni (**Fig. 19-26**) is a full-fledged IRBM. This two stage system uses a solid fuel first stage, copied from the SLV-3 space booster, while the second stage is a shortened version of the liquid fueled Prithvi. Its first flight was in 1989. The system has been tested to 2,500 km with a 1,000 kilogram warhead.

India has called the Agni a technology demonstrator and not a developed weapon system. In December 1996, India announced that the Agni "technology demonstrator" program was over.

In April 1999, India tested an upgraded Agni ballistic missile. Variously called the Agni-2 Agni-II, Agni Plus, and the Agni ER (Extended Range) the missile reportedly will carry a warhead of 1,000 kilograms to a range of 2,000 km. A CEP of 40 meters was reported but is not confirmed. The missile has an advanced inertial navigation system and may have mid-course updates using GPS.

This version is expected to be India's operational IRBM. The solid fuel missile is intended to be fired from mobile launchers **(Fig. 19-27)**. This is a major upgrade from the basic Agni which had a solid first stage but a liquid fuel second stage.

Fig. 19-27. Agni-2 in Parade

With the increased range of the new Agni-II, targets in Pakistan can be reached from almost anywhere in India as well as the major cities of China, both of whom India has fought wars with in recent times.

The possibility has been raised that India may be developing an Agni-III with a range of 3,500 km.

PAKISTANI MISSILE SYSTEMS

The Prithvi threat from India spurred Pakistani efforts to acquire ballistic missiles. Pakistan started to develop the Hatf ("Deadly") series in the early 1980's. They claim to have done this without assistance; however, Chinese or some other aid is suspected. There is also evidence that China delivered unassembled M-11 missiles to Pakistan. Rumors of Chinese M-9 missile or technology have also been associated with Pakistan's missile program.

Hatf Series

The Hatf-1 and 2 were both revealed during test firings in early1989. They are short to intermediate-range, road-mobile, solid fuel systems. Little is known about the missiles or their role.

Hatf-1

The Hatf-1 is a single-stage SRBM with a range of 80 km carrying a 500 kilogram warhead. The system is a road-mobile, single stage, solid propellant missile. It is believed to have entered service in 1992.

An improved version, the Hatf-1A was reported to have entered service in 1992. This missile is reported to have an increased range to 100 km.

Hatf-2

The Hatf-2 appears to have been developed in tandem with the Hatf-1 during the early 1980's. This system appears to be a two-stage solid fuel missile. Performance is believed to be in the range of 300 km with a 500 kilogram warhead.

The Hatf-2 is reported to be a mobile system; however, when displayed, they were transported on converted World War II-era anti-aircraft gun trailers instead of a more modern transporter-erector-launcher vehicle.

Hatf-3/4

There have been numerous reports of other Pakistani missile systems under development. Little is know about these systems. Possible missile systems have been speculated with a variety of different names.

One report mentions a Hatf-3 follow on with a range of 600 km. There has been some speculation that the Hatf-3 program may be related to the Chinese M-9 or M-11 missiles.

M-11 (Chinese)

Since 1993, there have been indications that Pakistan has received unassembled M-11's from China. In August 1996, U.S. intelligence officials reported a partially completed factory that could be ready in a year or two to produce "precise duplicates" of the M-11. An engine test stand was also located nearby. In 2000 the US Government publicly stated that China had proliferated the M-11 missile to Pakistan. The M-11 is a mobile system with a range of 300 km with a 500 kilogram warhead.

Ghauri (Hatf-5) Series

Development of a longer range missile system appears to have started between 1993 and 1996. The first public reference to the missile was in 1997. After the first flight test in 1998, North Korean involvement in this missile

development program appeared highly likely.

Fig. 19-28. Ghauri

Ghauri

In April 1998, Pakistan launched a missile 1,100 km with a 700 kilogram warhead. Flight time was just under 10 minutes. First identified as the Hatf-V, the missile was renamed the Ghauri **(Fig. 19-28),** after a historical Muslim who defeated the Hindu's in the 1100's.
The Ghauri missile is stated to have a range of 1500 km with a CEP of 250 meters and is assessed to be liquid fueled. The Ghauri appears to be a North Korean No Dong type missile.

Ghauri-2

In April 1999, one year after the Ghauri launch, Pakistan claimed to have launched an improved missile. The Ghauri-2 has a reported range of 2,000 km with a 1,000 kilogram warhead but was only tested to a range of 1,150 km. Flight time for this test was supposedly around 12 minutes. If there is a Ghauri-2, foreign, probably North Korean, help is suspected. However, there is no evidence other than the Pakistani press release that a Ghauri-2 missile was actually tested.

Shaheen Series

Shaheen

On April 15, 1999, one day after supposedly testing the Ghauri-2, Pakistan flight tested a new series of ballistic missile. The Shaheen (Eagle) **(Fig. 19-29)** is a solid fuel, mobile SRBM. While the system has an advertised range of 750 km with a payload of 1,000 kilograms, the four minute flight was to a distance of 600 km. A CEP of 10 meters has been cited in Pakistani reports.

Fig. 19-29. Shaheen TEL

Numerous other missile names have appeared in connection with the Pakistani missile programs. These include; Ghaznave (2,000 km), Shaheen-2 (2,300 km), Tipu (4,000 km), Babar, and Abdali.

ISRAELI MISSILE SYSTEMS

Israel has the most highly developed defense industry as well as the most advanced missile production in the Middle East. Israel has developed both a short range and a medium range ballistic missile. Both of these missiles are produced indigenously.

Jericho-1

The Jericho-1 is a short range missile based on the French MD-600 design. It can carry a 500 kilogram warhead a distance of 500 km. This solid propellant, mobile system was developed in the 1960's. First test fired in 1968, it was deployed around 1973. The missile can be launched from a railroad flatbed car or from a wheeled TEL vehicle.

Jericho-2

It is believed that the Jericho-2 was develop-ed in tandem with Israel's Shavit space launch vehicle **(Fig. 19-30**).

The Jericho-2 improved upon the performance of its predecessor, the Jericho-1. Developed in the mid-1970s to the early 1980s, its first fight was in 1986. It entered service in 1990.

The Jericho-2 is a two-stage, solid propellant system capable of delivering a 1,000 kilogram war-head a distance of around 1,500 km. This places most of the capitals of the Middle East in range as well as southwestern Russia.

As with the Jericho-1, the system is launched from either a wheeled TEL or a railroad flatcar.

IRANIAN MISSILE SYSTEMS

Iran acquired its first SCUD launcher and missiles in 1985-1986. It is believed that these were acquired from Libya and Syria. At this time, Iran had been at war with Iraq since September 1980.

The 300 km range of the SCUD-B permitted Iran to launch strikes against Baghdad, some 130 km from the Iranian border. In 1985, Iran fired an estimated 14 SCUD-B's at Iraqi cities. In 1987 and 1988, more SCUD missiles were then obtained; this time from North Korea. Reportedly between 90 and 100 missiles were purchased. In 1988, during the "War of the Cities" Iran fired 231 SCUD-B missiles at Iraq. Since the end of the Iran/Iraq War in 1988, Iran has continued to expand its missile program.

SCUD Missile Systems (North Korea)

Iran's current inventory of over 250 SCUD-B missiles was obtained from North Korea. The extended range North Korean SCUD-C (500 km) was subsequently purchased and Iran may have over 200 of these missiles. North Korea has also aided Iran in converting a missile maintenance facility into a SCUD-C assembly plant.

M-7 (CSS-8) Missile System (China)

In 1992, Iran purchased the Chinese M-7 short-range missile. Iran has also expressed an interest in obtaining the M-9 and/or the M-11 missiles.

A recent agreement between the U.S. and China, where China agreed to terminate its missile support to Iran, should preclude Iran from building a near-term offensive missile capability against U.S. allies or other countries in the gulf region. China has more or less honored this pledge. However, the Iranians are still getting missile technology assistance from North Korea and Russia.

Shahab-3

Iran's newest missile is the Shahab-3 (Meteor) which is currently being deployed. This MRBM is a mobile system based on the North Korean No Dong. The system was tested in Iran in July 1998 and has been assessed to have a 1,300 km range **(Fig. 19-31).**

Fig. 19-31 Shahab Articulated TEL

IRAQI MISSILE SYSTEMS

Iraq received its first ballistic missiles, SUCD-B's, from the FSU in 1974. In 1985, during the Iran/Iraq War, SCUD-B missiles were launched against Iraqi cities, particularly Baghdad. Most Iranian cities

were beyond the range of the Iraqi SCUD-B missiles. Tehran, the capital of Iran, is about 500 km from the Iraqi border. To overcome this deficiency, Iraq started an extensive missile program which centered on upgrading the performance of the SCUD-B.

SCUD and SCUD Modifications

While Iraq originally obtained its SCUD missiles from the FSU, Iraq has been able to develop an autonomous production capability. Using oil revenues to fund a huge missile technology procurement network, Iraq was able to obtain more advanced missile technology. During the late 1980s, the Iraqis made strides in their indigenous rocket program, apparently relying on foreign technical assistance and equipment.

Al Hussein

The first upgrade to the SCUD -B was the Al Hussein, **(Fig. 19-32)** with a range of 600 km, allowing strikes on Tehran, Iran. In 1988, during the Iraqi "War of the Cities" strikes, some 189 modified SCUDs were fired at Tehran. This resulted in a halt to Iran's small-scale missile attacks on Baghdad. Additionally, it hastened Iran's acceptance of a cease-fire in a war which was started by Iraq and had become bogged down in a World War I-style stalemate.

Fig. 19-32
Al Hussein

Al Hussein variants are approximately three feet longer than the standard SCUD-B and have reduced warheads, from 1,000 kilograms to 500. This reduction in payload weight and extra fuel provides for the extended range.

During the Gulf War of 1991, about 40 Al Hussein missiles were fired at Israel and around 46 were launched against Saudi Arabia.

Al Abbas

A second modification, designated Al Abbas, was tested in April 1988. This missile had an enhanced range of 900 km. However, it does not appear to have reached operational status. Only one flight test appears to have been conducted.

The extended range was obtained by reducing the warhead to around 150 kilograms and again, extending the missile body; this time by more that six feet over the original SCUD-B.

Since the Gulf War, Iraq has been prohibited from having or developing ballistic missiles with ranges over 150 km. However, they continue to test short range missiles within this limit.

SAUDI ARABIAN MISSILE SYSTEMS

Saudi Arabia obtained its first ballistic missile during the late 1980s. Although the missiles were purchased from China around 1986, it was not disclosed to the world until 1988. Currently, no other ballistic missiles are reported to be operational or under development in Saudi Arabia.

CSS-2 Missile System

Saudi Arabia is believed to have a total of approximately 12 launchers and 50 CSS-2 missiles deployed at two sites, located 100 and 500 km south of Riyadh, Saudi Arabia.

The CSS-2 can carry a 2,000 kilogram conventional warhead to a distance of 2,500 km. This range brings countries throughout the Middle East within striking range; yet, none of the Saudi CSS-2s were fired during the Gulf War.

The missile is far too inaccurate to be used against a point target with a conventional warhead. The Saudis stated that the war was against the leadership of Iraq, not its people, thereby acknowledging the missile's inaccuracy and its consequent potential for civilian causalities. Saudi Arabia has further stated that they would not obtain or use chemical or nuclear warheads on their CSS-2 missiles. In April 1988, they signed the Nuclear Nonproliferation Treaty.

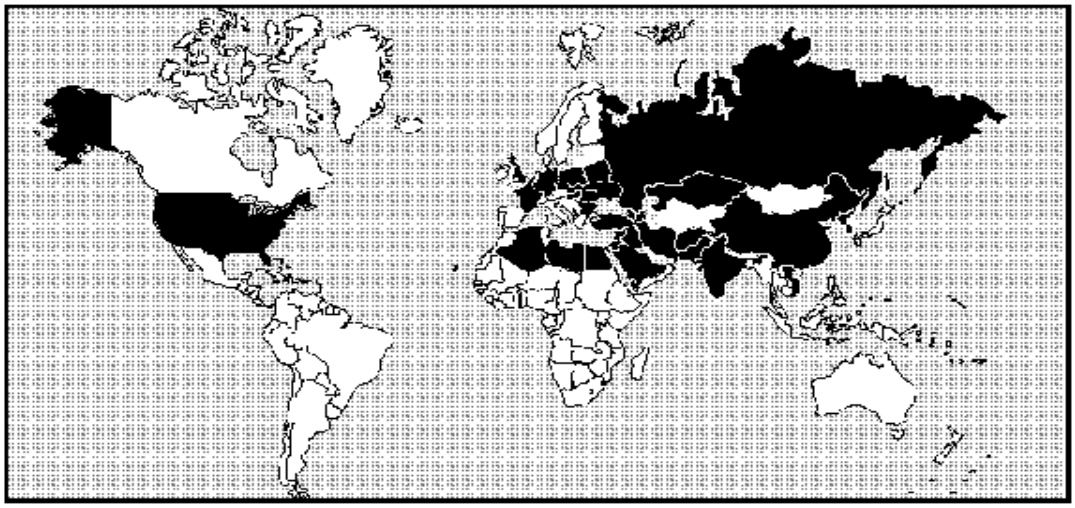

Fig. 19-33. Countries in black have, produce or are developing theater ballistic missiles

SYRIAN MISSILE SYSTEMS

Syria was one of the FSU's staunchest allies in the Middle East. Beginning in the early 1970s, Syria began receiving the SCUD-B and other battlefield missiles. It is believed that Syria has 200 SCUD-B missiles and 18 launchers. They also have more modern SS-21 solid fueled short range missiles.

LIBYIAN MISSILE SYSTEMS

Libya obtained SCUD-Bs from the FSU during the 1970s. Since then, it has attempted to purchase other new systems. Additionally, reports of an indigenous missile production program are persistent. This missile development program, Al Fatah, has been in progress since at least 1981. Despite the apparent slow progress, Libya's relative wealth allows the country to continue seeking an indigenously produced ballistic missile.

MISSILE PROLIFERATION

Theater ballistic missile proliferation is becoming an ever increasing problem in the world. Many nations possess theater ballistic missiles and some have made these systems/technology available for purchase (see **Fig. 19-33**). Today, proliferation poses a significant threat to U.S. commanders in overseas locations and this threat will continue to grow in the future.

In 1986, Libya fired two ballistic missiles at a U.S. communications installation on the Italian island of

Lampedusa. Although they missed, equally ominous was Qaddafi's boast that if Libya had possessed a missile that could reach New York City at the time of the U.S. air raid on Tripoli, he would have used it. Although that may have been an empty threat at the time, Americans cannot be overly optimistic about the prospect of missiles under the control of a volatile political leader.

REFERENCES

Ballistic Missile Threats. Centre for Defence & International Security Studies, Lancaster University, United Kingdom, http://www.cdiss.org.

CATO Institute, Washington D.C., http://cato.org. "Publications - Foreign Policy Briefing, No. 10", July 14, 1991.

DOD, *Soviet Military Power*; 1986, 1987, 1988, 1989 and 1990 Editions.

"Foreign Missile Developments and the Ballistic Missile Threat to the United States Through 2015," September 1999, National Intelligence Council, CIA's Office of Public Affairs, http://www.cia.gov/cia/publications/nie/nie99msl.html.

History - Rocket History. Kennedy Space Center, Florida, http://www.ksc.nasa.gov.

Intelligence Resources Program. Federation of American Scientists, http://www.fas.org.

Issues - Defense and Foreign Policy. Center for Defense Information, Washington D.C. , http://www.cdi.org.

Jane's Strategic Weapons Systems, Sep. 1995, Jane's Information Group Inc.

"North Korea's Ballistic Missile Program." "A History of Ballistic Missile Development in the DPRK." Joseph S. Bermudez Jr. http://www.cns.miis.edu/

"PROLIFERATION: THREAT AND RESPONSE."
http://www.defenselink.mil/pubs/prolif97/

Public Affairs Office - History. National Aeronautics and Space Administration, http://www.hq.nasa.gov.

Soviet Military Capabilities, 1986, HQ SAC.

"Theater Ballistic Missile Warning." United States Space Command, Peterson AFB Colorado, http://spacecom.af.mil.

"The Threat from Ballistic Missiles."
http://internationaldefense.com/pi-threat_of_tbm.html

"Ballistic and Cruise Missile Threat", NAIC-1031-0985-00, National Air Intelligence Center, Wright-Patterson AFB, OH, Sep 2000