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Proliferation of Missile Delivery Systems for Nuclear Weapons

Submitted by

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Concurred in by the

UNITED STATES INTELLIGENCE BOARD

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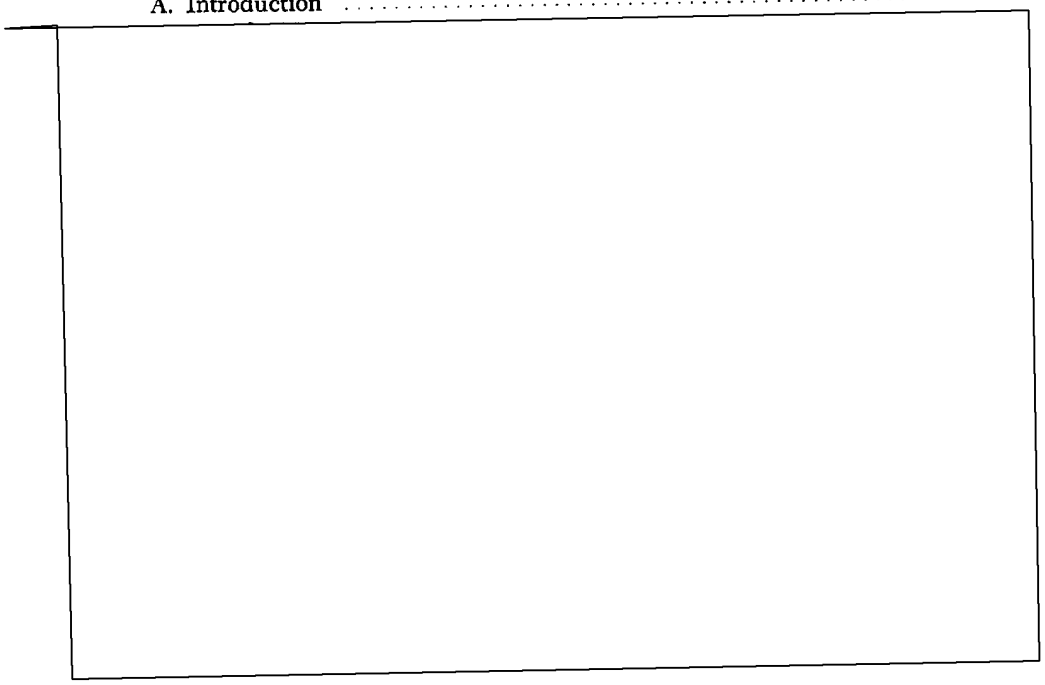

PROLIFERATION OF MISSILE DELIVERY SYSTEMS FOR NUCLEAR WEAPONS

THE PROBLEM

To estimate the capabilities and incentives of additional countries to acquire nuclear-capable ballistic missile delivery systems over the next 10 years.

NOTE

In accordance with the terms of the request which initiated this estimate, we discuss the possible spread of missile delivery systems in coming years, but we do not discuss in detail the spread of nuclear weapons compatible with such systems. Our most recent estimate on the latter subject is NIE 4-66, "The Likelihood of Further Nuclear Proliferation," dated 20 January 1966, the principal findings of which are still valid. The nuclear problem is considered in this estimate only in terms of the ease or difficulty with which each nation might obtain warheads compatible with missiles it might acquire, and the economic burden which a combined missile and warhead program would impose.

We consider in this estimate all countries which do not already possess missile delivery systems for nuclear weapons; the USSR, the US, Communist China, France,[1] and the UK either now have such systems or are in the process of acquiring them.

We have excluded from discussion missiles with a range of less than 200 n.m., but we consider all ballistic missiles of greater range as long as they could be used by a given nation for "strategic" objectives. The term "strategic missile" is employed in this estimate to describe

a missile designed to strike at some enemy's homeland and not at his troops in the field or supply routes directly behind the front.

CONCLUSIONS

A. Although basic missile technology is already widely known, and many components for missile systems can be bought on the world market, the development, production, and deployment of an effective nuclear-capable ballistic missile system is a difficult and expensive undertaking which requires a sophisticated industrial base and a heavy commitment of national resources.

B. We consider that, over the next decade, there are only six nations, aside from those already having strategic missile systems, which are serious candidates for acquiring such systems. These nations either have or may come to have the requisite economic strength to produce missiles or have a strong political incentive to acquire them, or both.

C. There are a number of other nations which have, or might come to have over the next 10 years, the economic strength to support a missile development program, but which lack foreseeable incentive to undertake one. These nations are discussed in Part III, paragraphs 48-50.

D. Some countries having space or military missile programs are likely to find the sale of components and even complete missiles economically or politically attractive. Few, if any, of the less developed nations, however, would be able to overcome the complexities of putting together the various elements of a workable missile system; they could obtain a meaningful capability only if they were provided with whole systems, already tested and operational.

DISCUSSION

I. GENERAL CONSIDERATIONS

A. Introduction

1. Over the coming decade, a number of nations may seek to acquire strategic ballistic missiles capable of delivering nuclear warheads. Some nations may be motivated to do so more by a desire for national prestige than by realistic military considerations. Others may come to believe that ballistic missile systems would guarantee them regional hegemony or provide them with a deterrent defense in the face of some regional threat. No other nation can hope to establish a missile system comparable in size and effectiveness to the systems of the two superpowers. Some governments, however, may believe that the possession of even a few nuclear-capable missiles would enable them to play a greater role in world affairs.

2. Ballistic missile systems are expensive, but they provide unique military advantages. They are at present virtually invulnerable to interception or, if they are hidden or deployed in hardened sites, to destruction before firing. A nation capable of deploying a missile delivery system equipped with nuclear warheads might achieve great regional strategic power with only a few missiles. Lacking nuclear warheads, a strategic missile force is little more than very expensive long-range artillery, and the strictly military justification for its deployment appears minimal. Still, nations without nuclear warheads might hope to acquire them some day, depending in the meantime on high explosive or possibly BW/CW warheads.

3. Nations wishing to acquire ballistic missile systems must determine strategic criteria in light of their own unique political and geographic situations. From these criteria, they can define their specific force objectives in light of the means likely to be available to them. Strategic requirements for a missile delivery system vary widely as between nations. A system capable of delivering a nuclear warhead 300 miles would provide India a deterrent to threats from Pakistan; it could not counter a threat from China. Such a system would form an Israeli deterrent to threat from the UAR, but it would not meet Japanese needs for a deterrent force and it would breach Sweden's self-imposed renunciation of strategic weapons which the USSR might find provocative.

4. In order to determine what sort of a missile force it should seek, a country would have to decide on what warheads were likely to be available and the distances over which these warheads would have to be delivered; the numbers of missiles in combination with available warheads which would provide adequate target destruction or credible deterrence; the levels of accuracy needed for attack on military targets or on enemy population centers; the characteristics of missile and launcher which would provide a suitable reaction time; and finally, the form of deployment which would best reduce the vulnerability of the missiles

to enemy attack. There may be some nations, however, which will minimize strictly military considerations and undertake the acquisition of a crude missile force for purely political purposes.

5. Whatever combination of range, payload, and accuracy may be dictated by strategic considerations, there remains a wide choice of specific hardware. Delivery vehicles may be single or multiple stage, their propellants solid, liquid, or combinations of the two. Each type of propellant presents both advantages and disadvantages. If liquid, propellants may be cryogenic [2] or storable. Cryogenic propellants are difficult to handle, require elaborate production, transportation, and storage facilities, and increase the reaction time of the system. Although some storable liquids are also difficult to handle because of their toxicity or corrosiveness, they can provide shorter reaction time. Solid propellants require advanced technology to produce and present formidable design problems in flight control, but solid propellant rockets can be stored for a long time and fired with very little preparation.

6. A similar range of choices exists for guidance and control systems. Radio or radar guidance is cheaper and more readily obtainable than inertial guidance and cuts down on total vehicle weight since much of the navigation and computation equipment stays on the ground. But guidance antennas are difficult to protect against enemy attack. Furthermore, missiles guided by radio or radar must be fired sequentially rather than in salvo, unless duplicate guidance installations are provided for each missile, a very expensive solution to the guidance problem. Some nations might attempt to devise guidance systems adapted from readily obtainable aircraft autopilots, but the Circular Error, Probable (CEP)[3] of a missile guided by this means might be on the order of 5 or 10 n.m. at a range of 500 n.m. Whatever guidance system is used, a country deploying missiles would need precise geodetic data for effective targetting. In general, any nation undertaking the development of an effective missile capability would probably find the achievement of satisfactory accuracy to be one of the most expensive and time-consuming aspects of its program.

7. Finally, nations which undertake the development of medium or longer range missiles [4] would face the problem of designing a reentry vehicle (RV) capable of surviving the heat of high-velocity atmospheric reentry and maintaining the accuracy of its trajectory during its high-stress transition from flight in vacuum to flight in the atmosphere. RV design and construction is a difficult matter, and although the technology involved is becoming more widely known,

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[2] Cryogenic fuels are gaseous at normal temperatures. In order to remain liquid, they must be kept at very low temperatures prior to ignition.

[3] Expressed as the radius of that circular area within which 50 percent of those missiles which are successfully launched and which do not malfunction in flight will strike.

[4] Ballistic missile ranges are commonly categorized as follows:
Short Range (SRBM)—under 600 n.m.
Medium Range (MRBM)—600-1,500 n.m.
Intermediate Range (IRBM)—1,500-3,000 n.m.
Intercontinental Range (ICBM)—more than 3,000 n.m.

the RV problem is likely to present another obstacle to the success of domestic missile development programs.

8. It is clear, then, that some components of missile systems (e.g., propellants, guidance, RV design) require higher orders of technology than others. The ability of a nation to acquire these key components from foreign suppliers could weigh heavily in its initial decision to undertake a domestic missile development program and could have much to do with subsequent choices of specific hardware and the tempo and cost of the program.

9. It is unlikely that any nation set on acquiring a strategic ballistic missile system would be forced to design and manufacture the whole system itself. Some nations may find it possible to purchase complete systems, as Israel is now doing. Some—like the UAR—may depend heavily on the wholesale importation of scientists and technicians from more highly developed nations. Any nation with sufficient cash can purchase a good deal of advanced technology in the form of finished missile components, specialized machine tools, and advanced computation and testing equipment. Nations with adequate indigenous scientific capability can take advantage of the great amount of technical information in open literature. Some may obtain key technology through espionage. Germany, France, the UK, and to a lesser extent, Japan have access to US missile technology through normal channels established between US aerospace contractors and their foreign subsidiaries and licensees. Many foreign technicians have benefitted from their nations' cooperative programs with the US; some have been trained in US plants and at US launch facilities.

10. If US contributions to such regional space research groups as the European Launcher Development Organization (ELDO) and the European Space Research Organization (ESRO) increase, participating nations will enjoy greater access to US technology, even if at second hand. Air defense missiles and sounding rockets, although without direct strategic missile significance, are already widely available, and many nations have acquired basic technical experience in the production (usually under license), testing, and maintenance of these devices. Through the process of "reverse engineering," i.e., the careful disassembly of a missile and analysis of its component parts, many nations could shorten research and development time in their own missile programs. We will discuss the contributions to national programs of each of these sources of missile technology in subsequent sections of this estimate.[5]

11. The costs of, and time needed for, acquiring strategic missile systems would vary considerably from nation to nation with differences in strategic requirements, hardware choices, and domestic cost structures. Long-range missiles cost more than short-range missiles; accurate missiles more than inaccurate ones; nuclear warheads much more than high explosive or CW/BW

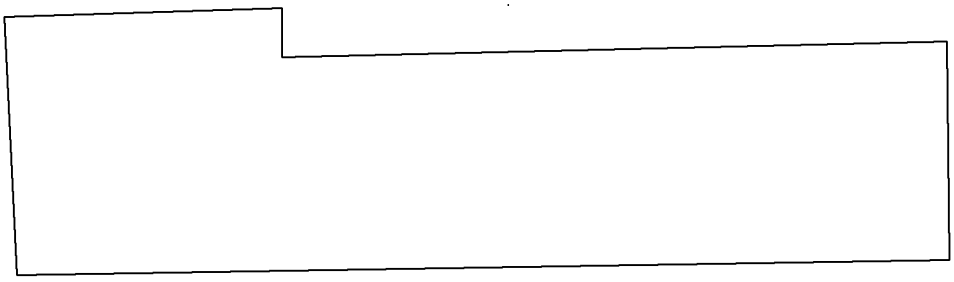
[5] Exports of US equipment and technology relating to ballistic missiles are subject to various US controls. US nonproliferation policy provides guidelines applicable to military sales and to cooperative defense projects as well as to international arrangements entered into by NASA. Detailed discussion of these domestic matters, however, is not within the scope of this estimate.

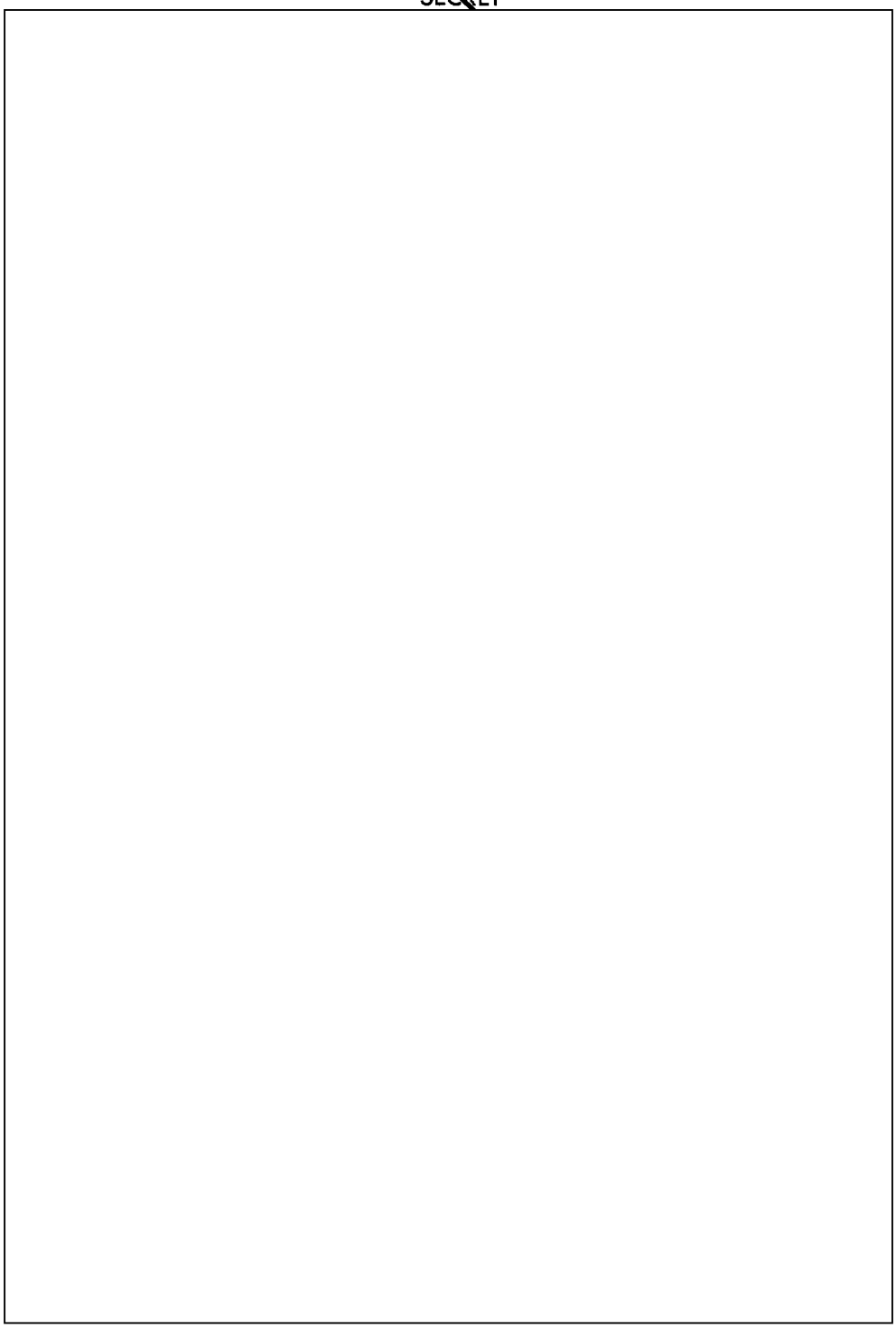
warheads. Some nations, such as Germany and Japan, possess advanced industrial bases readily adaptable to fairly rapid missile production. Others, such as India and the UAR, lack such bases, and their total missile development costs would include considerable investment in time-consuming basic industrial development. Variations in the domestic cost structure would also affect missile development costs; Japan, for example, might be able to develop a given missile system more cheaply than West Germany. Finally, the pace of missile development would play a sizable role in determining eventual costs. Crash programs are very expensive, as is the rigid adherence to ambitious development and production schedules and performance criteria.

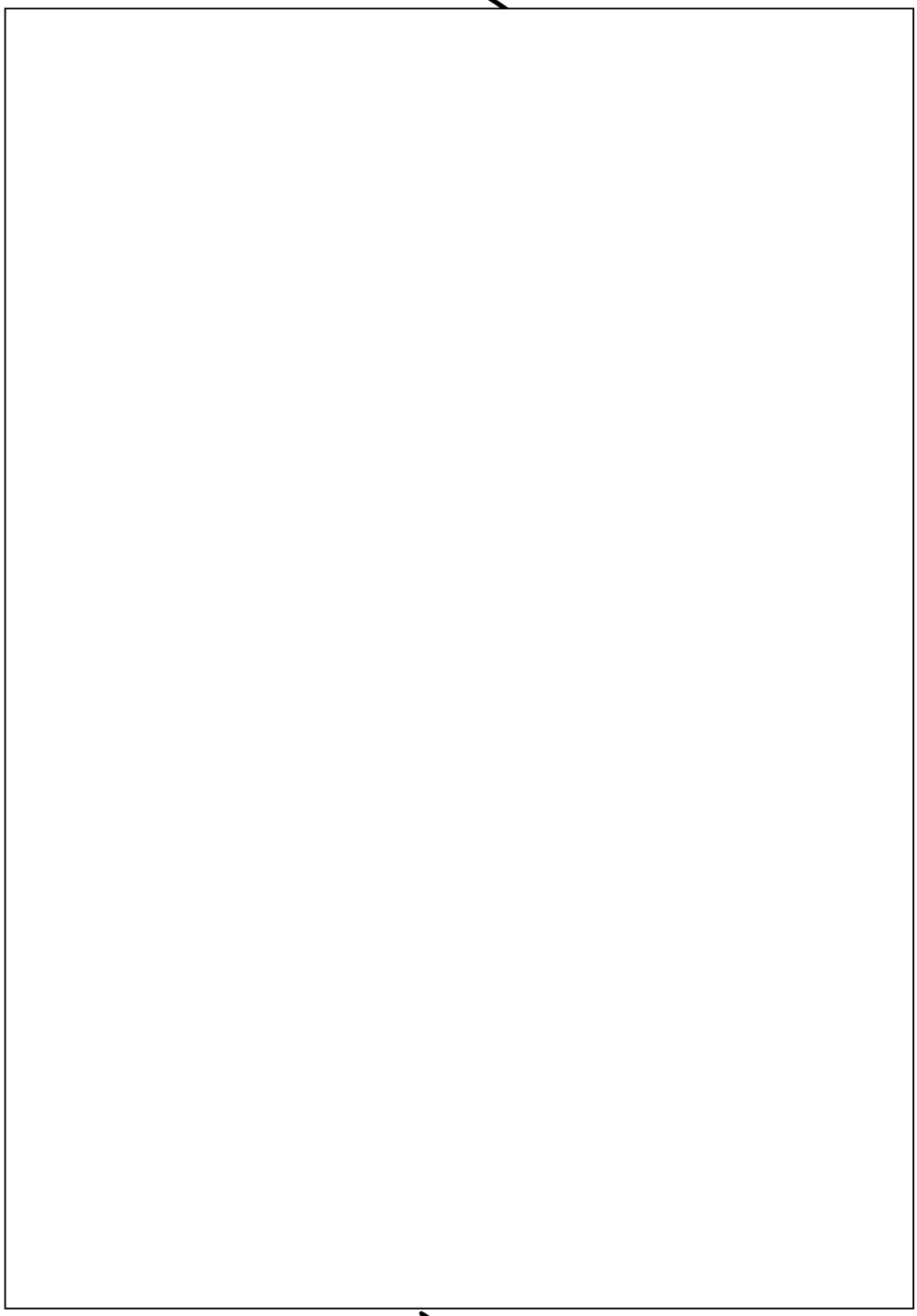
12. Nations undertaking the domestic development, production, and deployment of a strategic missile force would probably have to invest heavily in specialized test equipment. As soon as a research and development effort reaches the hardware stage, individual components must be exhaustively tested with specialized facilities, some of which must approximate the harsh environment within which a missile must operate. Such facilities are expensive, but nations which forego testing with wind tunnels, vacuum and low temperature chambers, vibration tables, and so forth would run serious risk of failure.

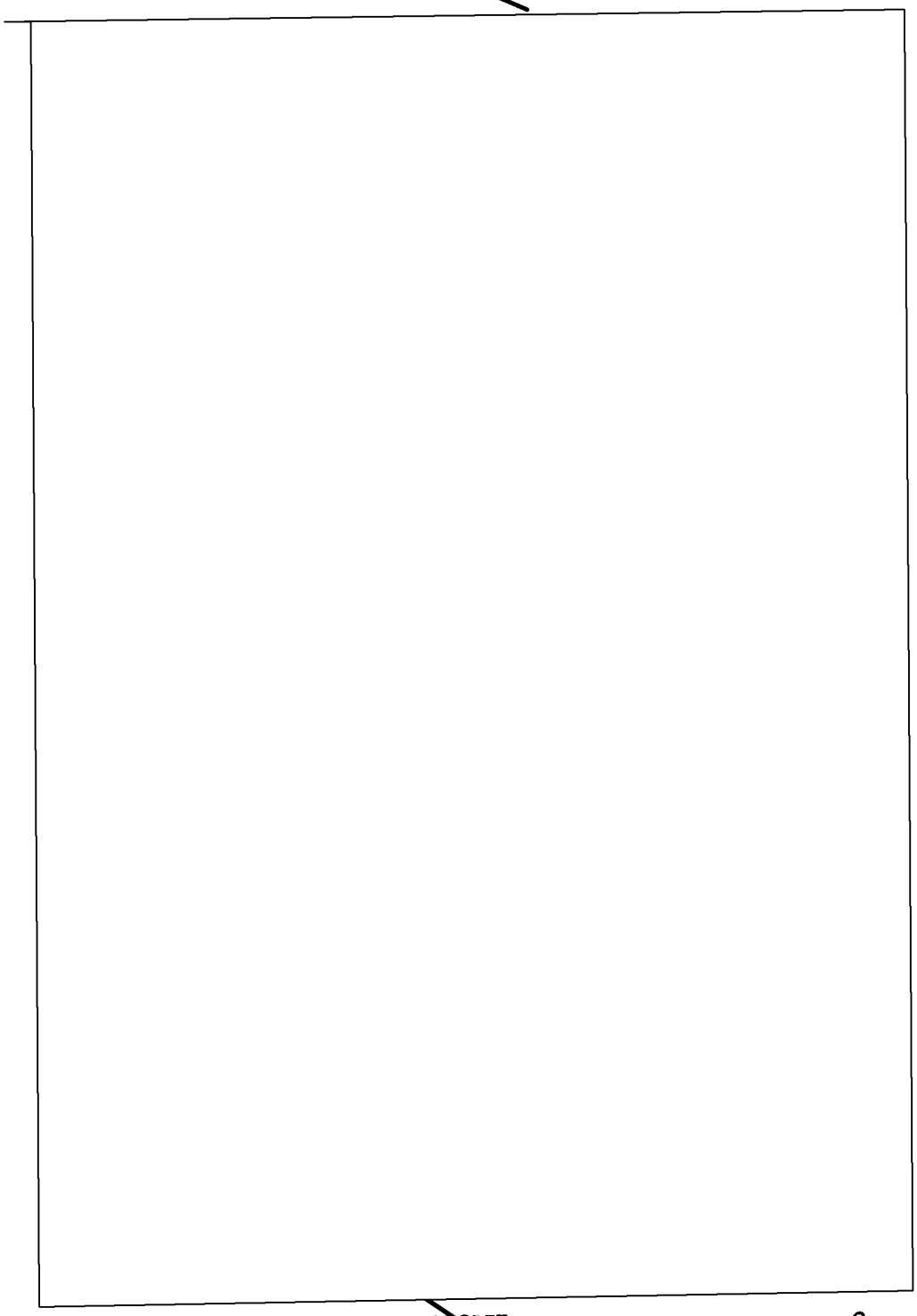
13. The successful flight testing of a prototype missile and subsequent production models requires an instrumented test range. The development of high degrees of accuracy, reliability, and readiness requires extensive testing over a long period. Some nations might be able to test their missiles on ranges established by friendly countries, as the British have used the Woomera range in Australia. Those nations which—like Israel—purchase complete missile systems from more advanced nations might try to include in the transaction provisions for the periodic use of a test range for postdeployment testing and crew training. But nations desiring freedom from any dependence on other nations would be forced to build and instrument their own test ranges.

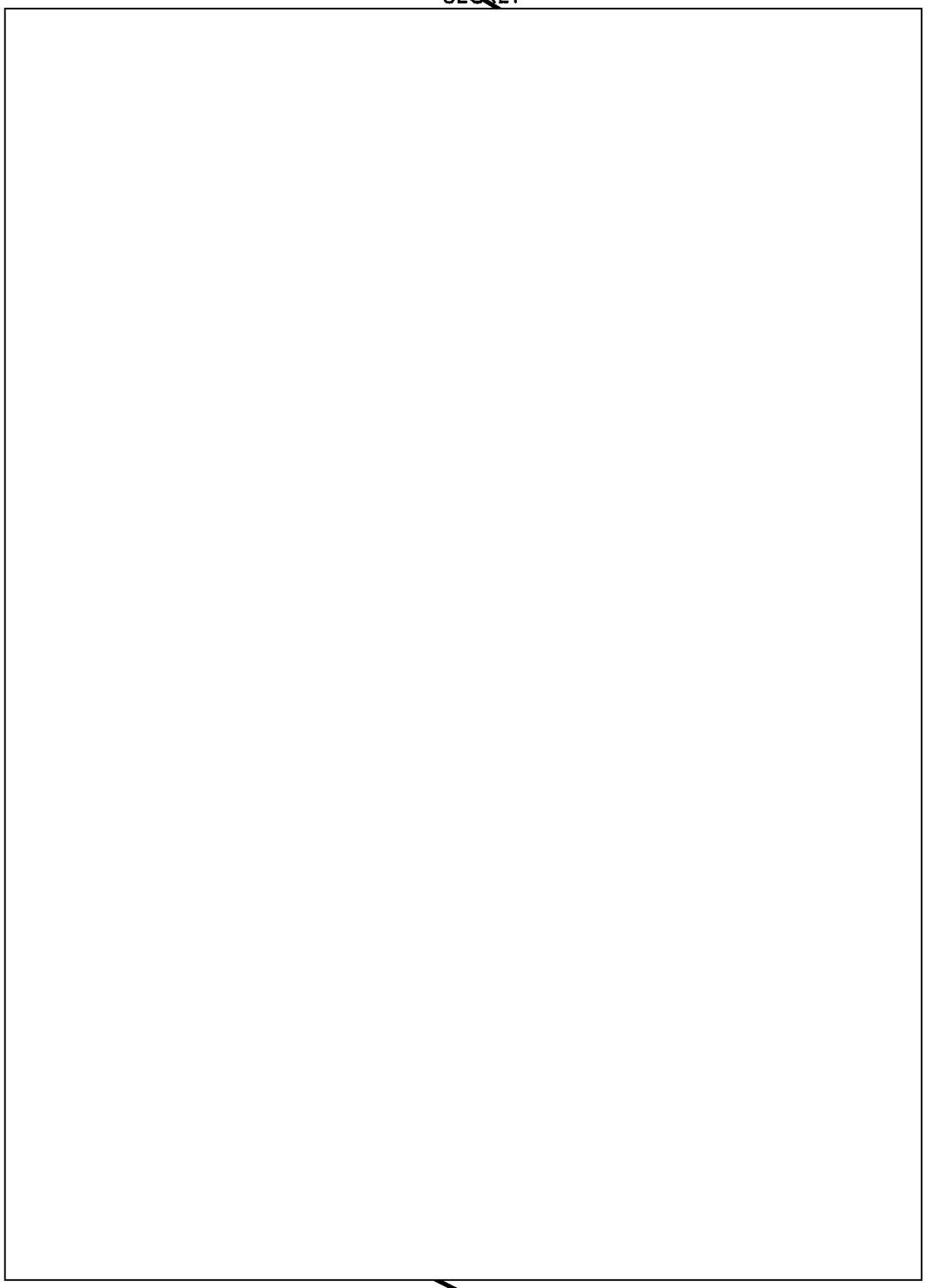
14. However it is acquired, a missile system must be maintained in readiness. Missiles are complex; individual components can deteriorate in time, and they must be tested and replaced on some sort of regular schedule. In addition, most nations would make periodic firings in order to train firing crews and to demonstrate the system to potentially hostile powers. Insuring a continuing supply of replacement components to maintain readiness and to support a regular test and demonstration firing program can be a major problem for even a modest missile force.

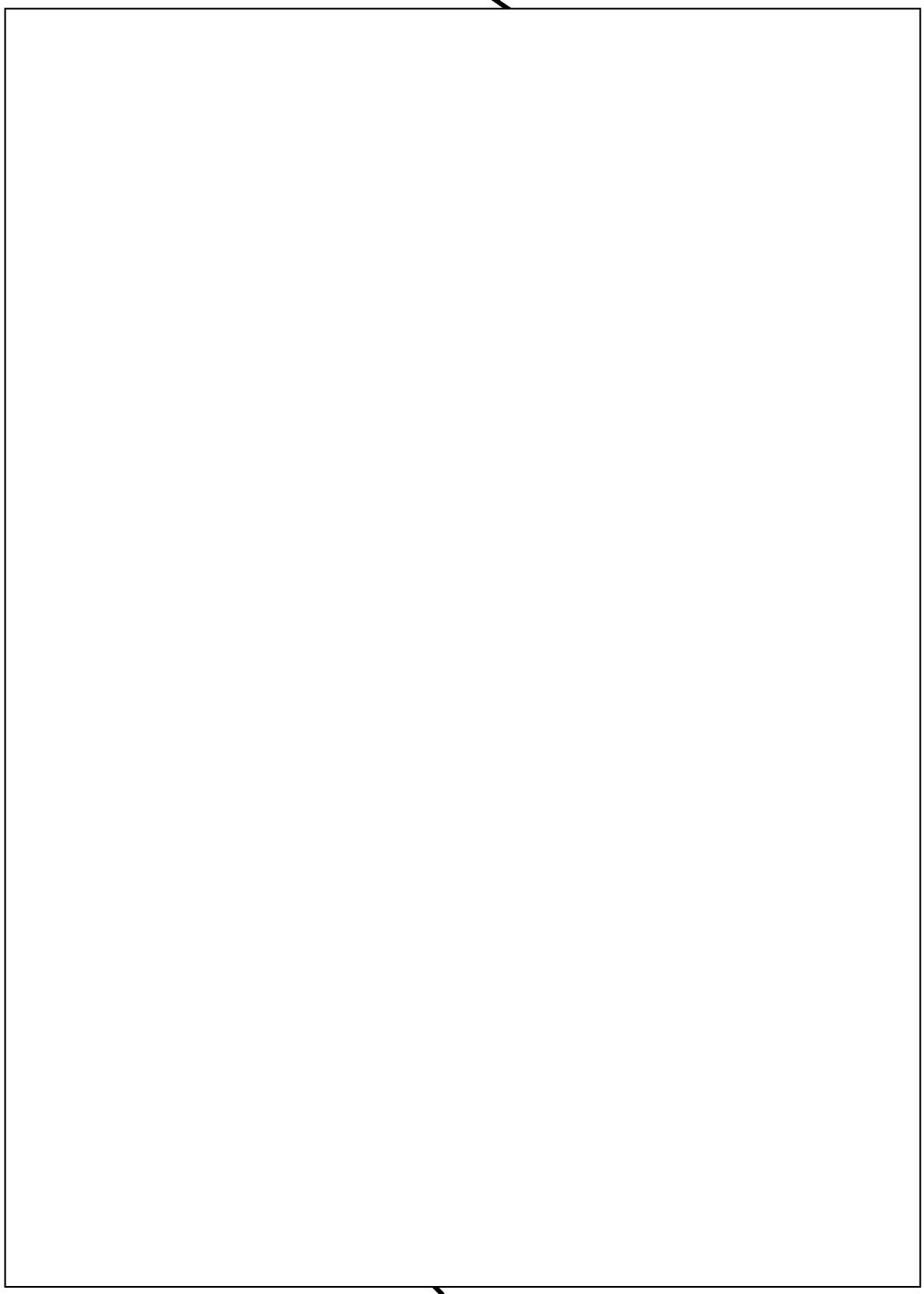


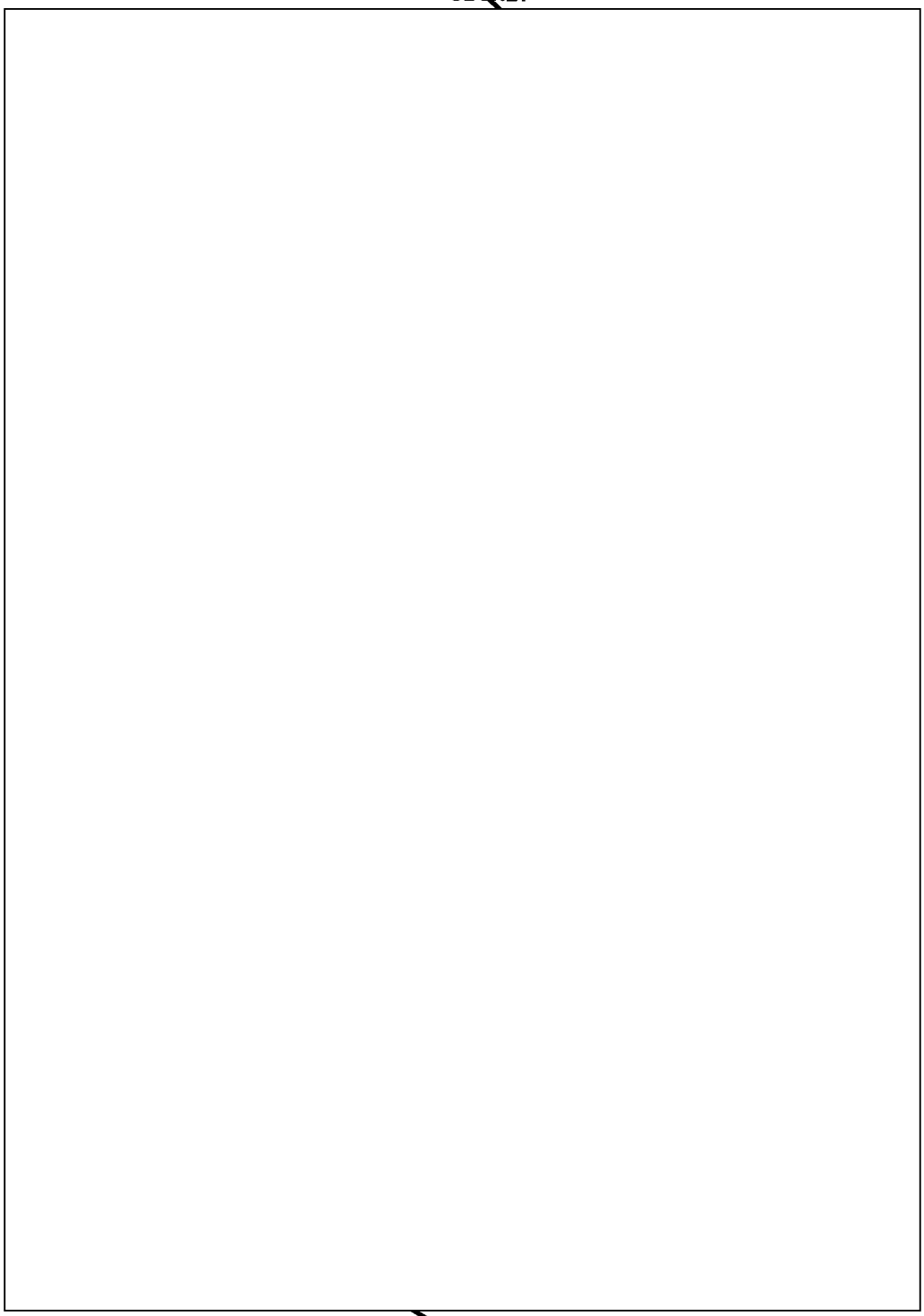


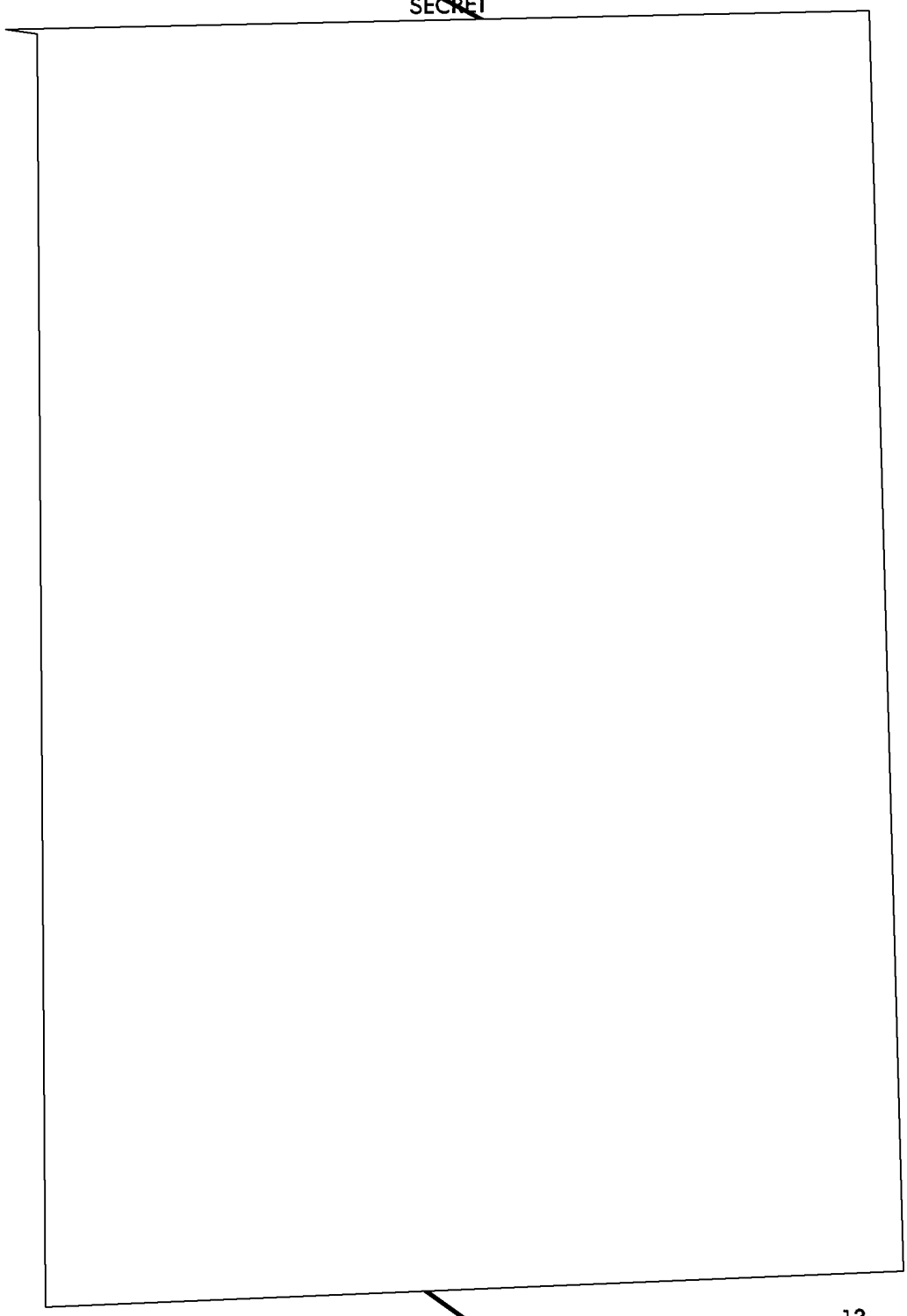


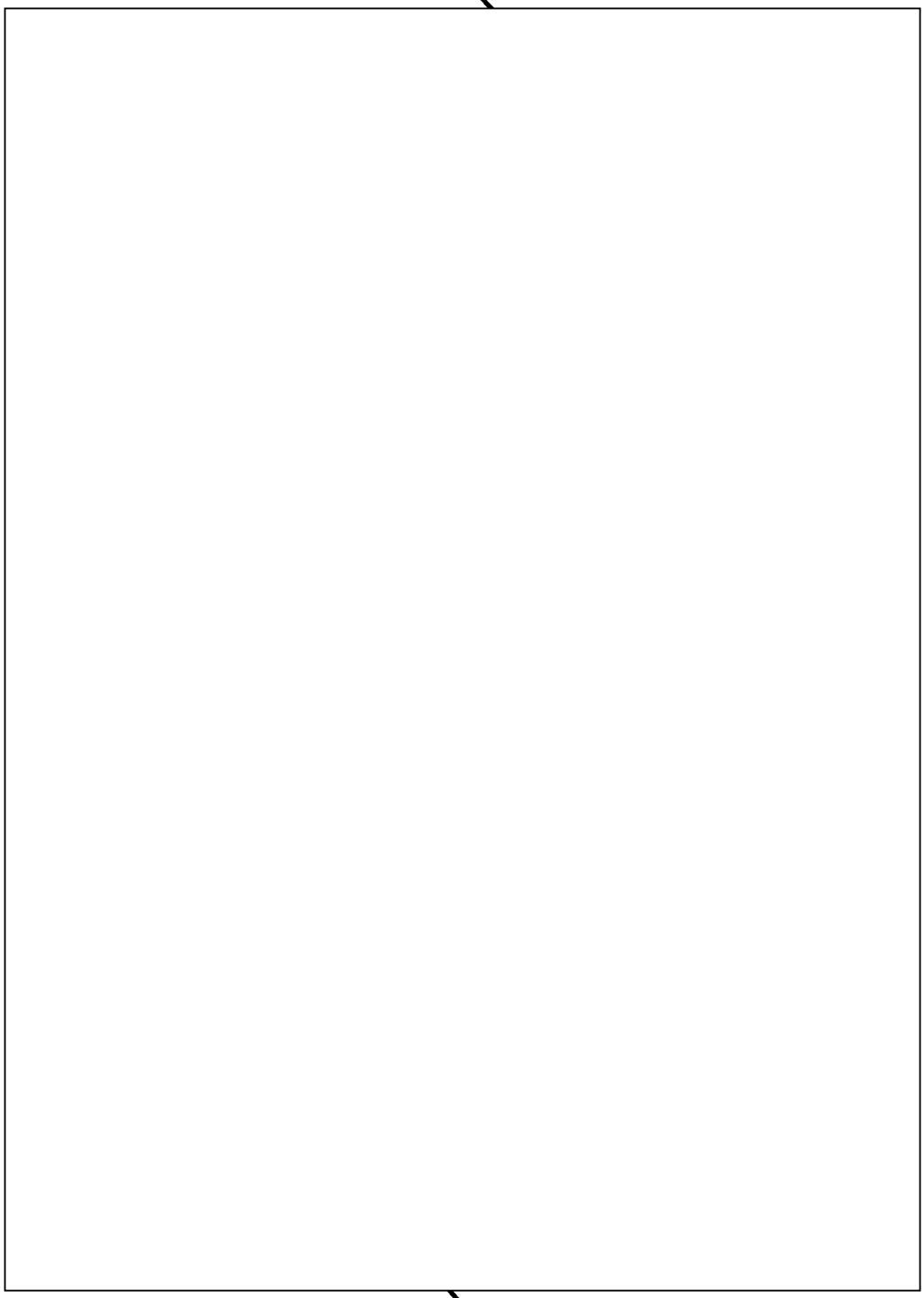


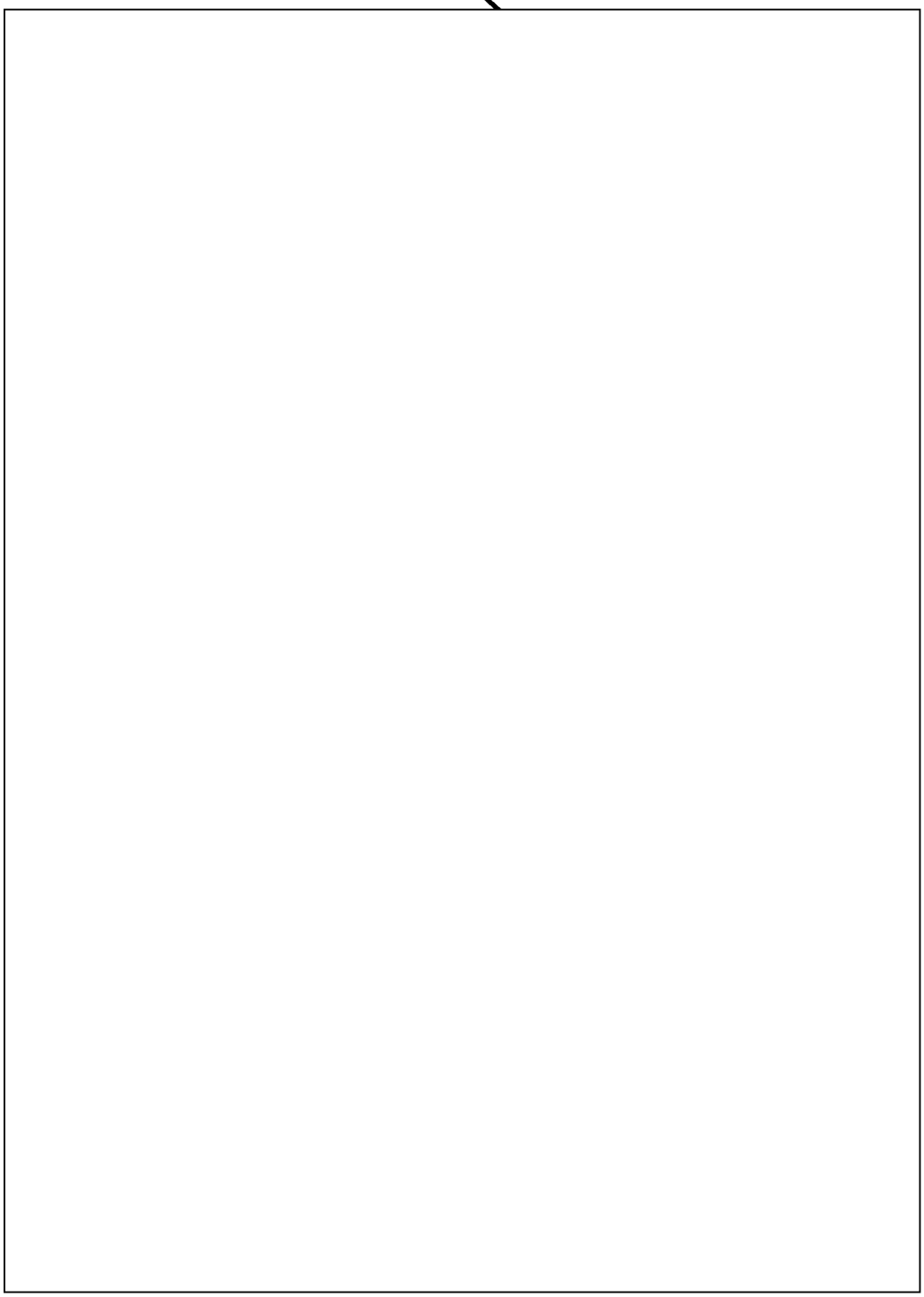


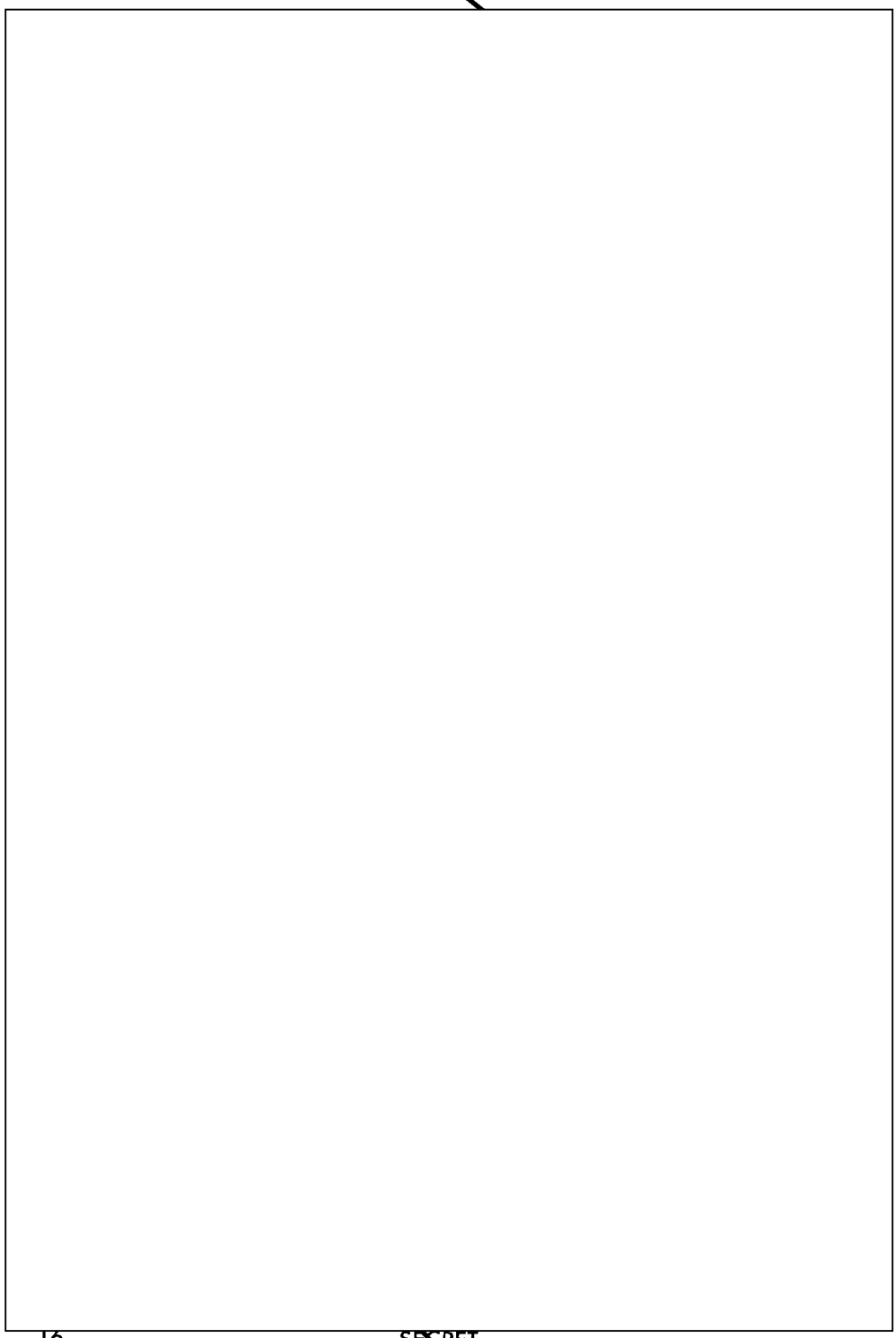


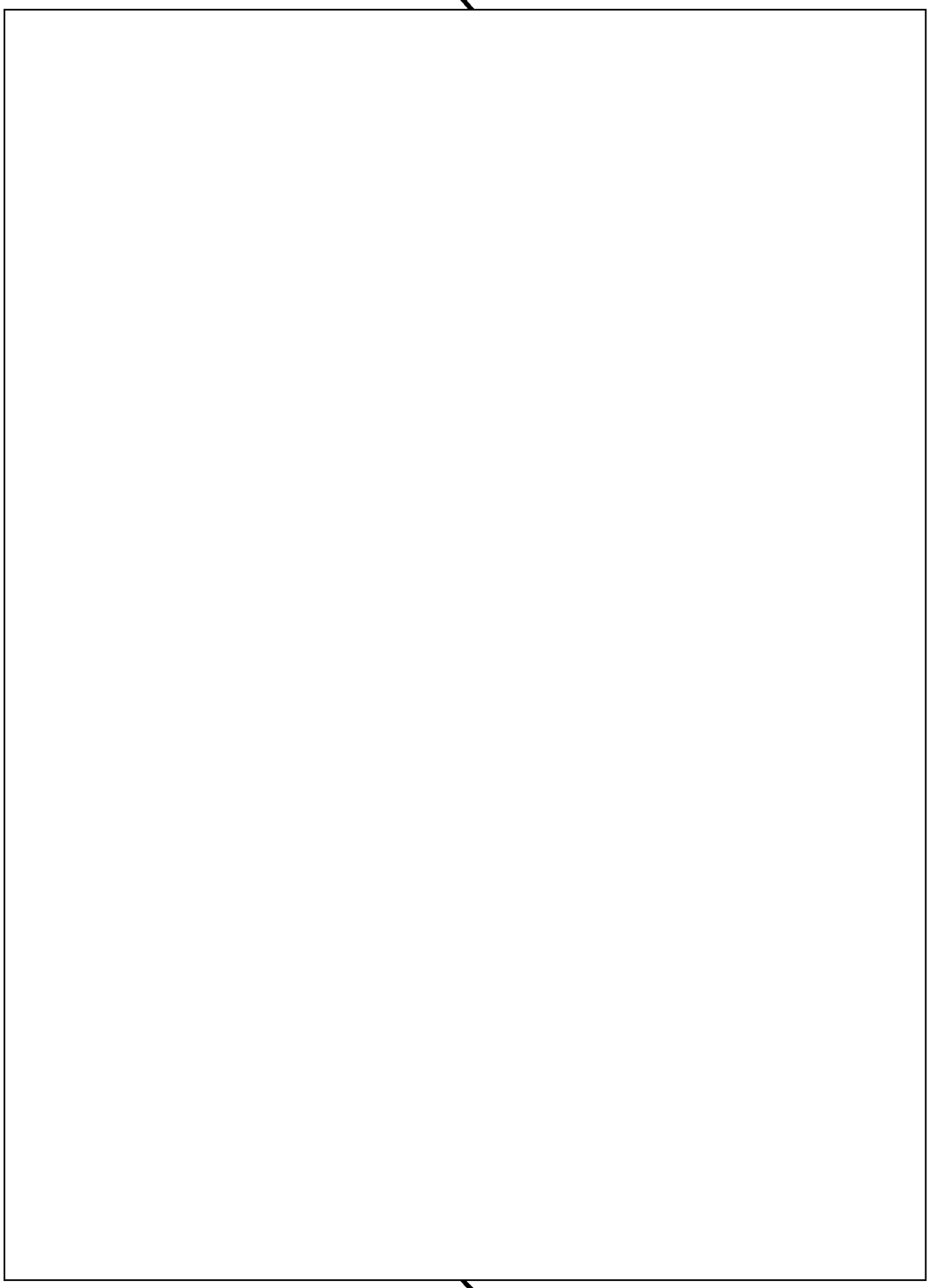


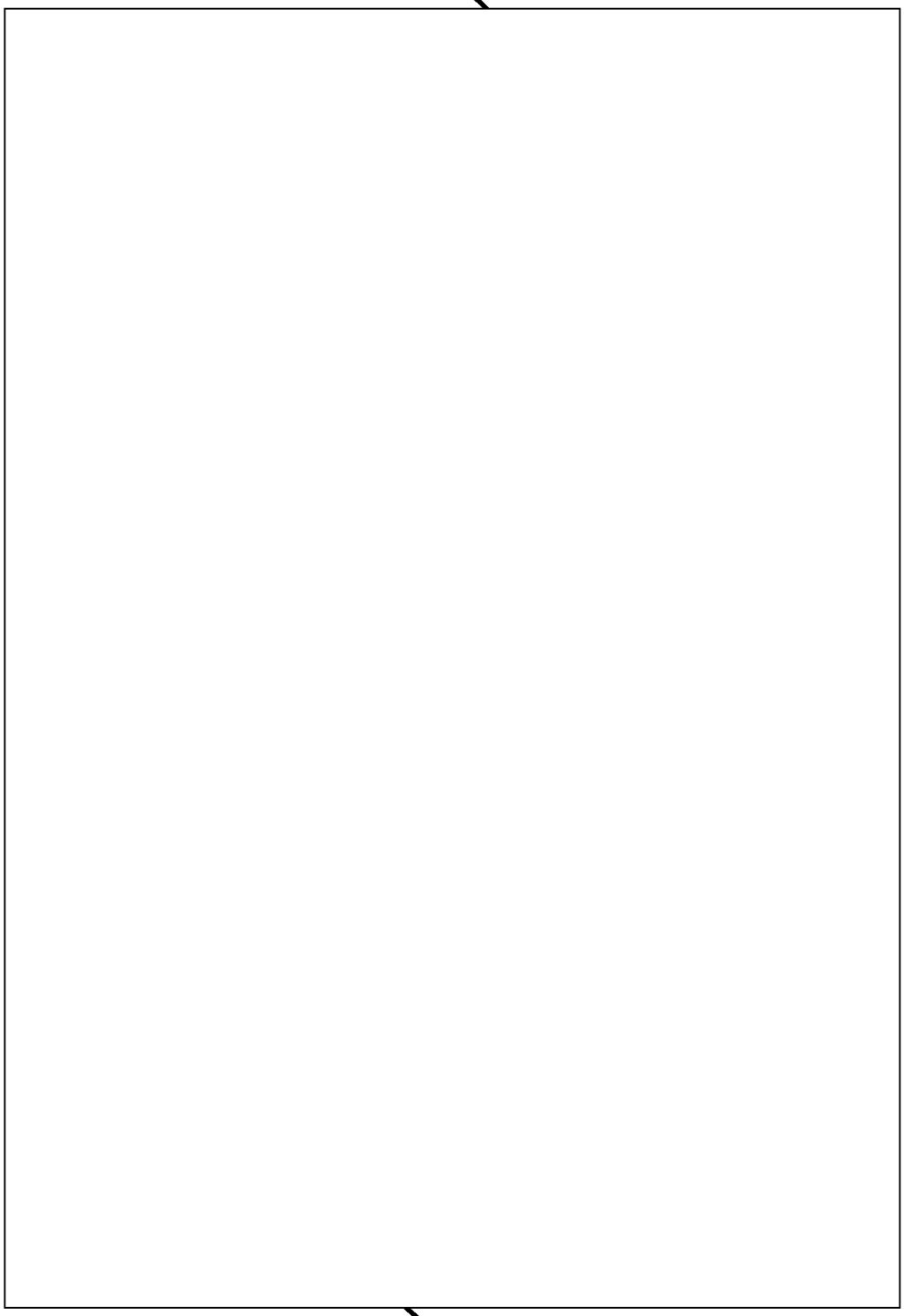


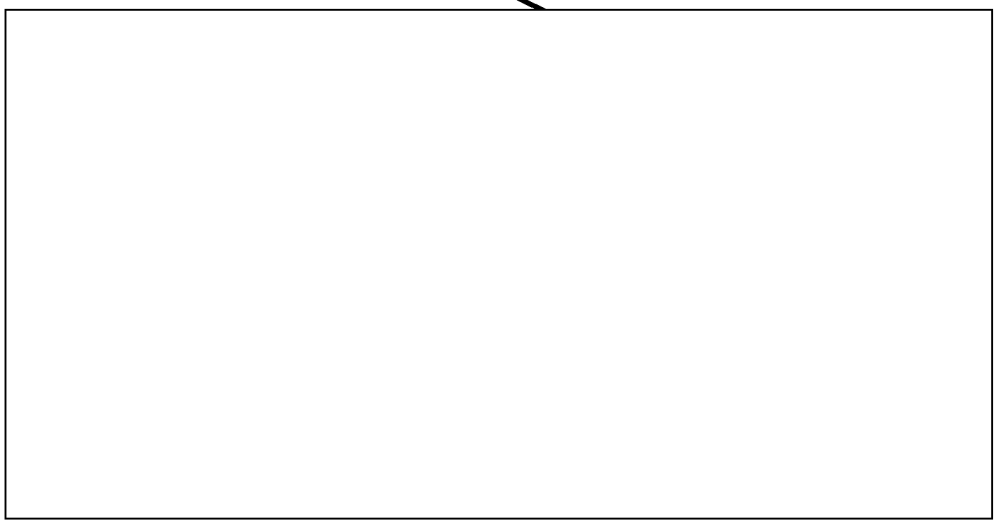


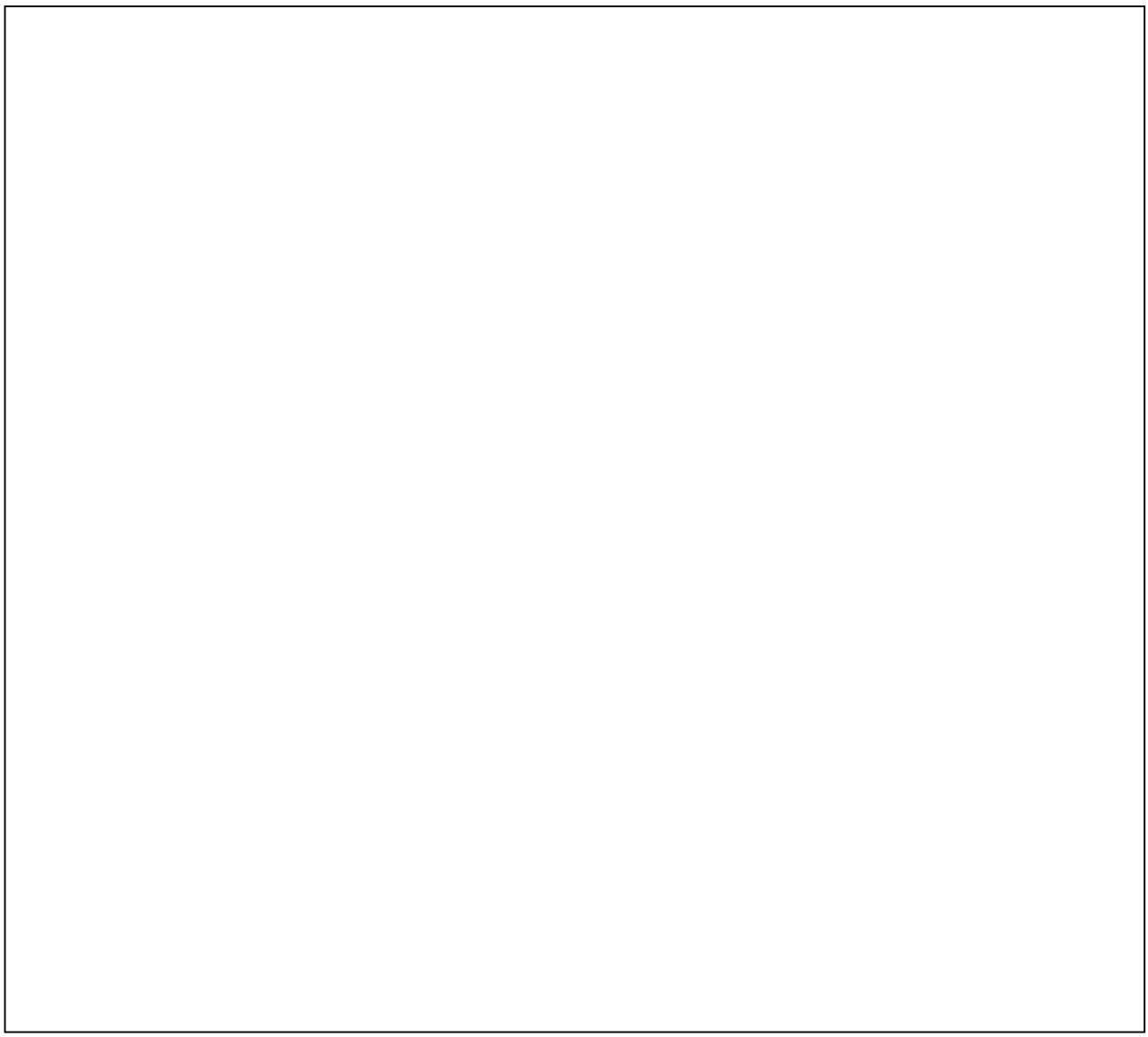












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