Misestimation: Explaining US Failures to Predict Nuclear Weapons Programs

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Forthcoming in Intelligence and National Security, Summer 2014

Appendix

Germany, 1941-1945[1]

A major justification for the US nuclear weapons program was the fear of a German program. Some scientists were concerned that the Germans had a six-month head start. However, the US had made no effort to either assess existing intelligence or to systematically collect intelligence until late 1943. Consequently, early assessments were based primarily on searches of open literature in German nuclear physics. The first assessment was made by physicist Arthur H. Compton, who concluded in June 1943 that there was a lack of censorship of publication of papers on nuclear physics, including bomb-relevant topics such as uranium enrichment methods and chain reactions. British intelligence concluded based on similar information in the fall of 1943 that Germany did not have a serious atomic bomb program; in particular, a British assessment concluded that a six-month delay in publication of papers relevant to plutonium production reactors indicated that information had been under review for classification, but then had been released. Robert Furman, who was appointed in late 1943 by General Leslie Groves, Chief of Army Special Weapons Project at Los Alamos, to direct intelligence efforts regarding the German bomb program, read the British report, but concluded that it was based on insufficient information. Physicist Philip Morrison, studying the same literature in September of 1943, concluded that German physicists understood chain reactions; Morrison focused more on capabilities, rather than an assessment of activities, and as a result produced a more worrisome estimate. Similarly, Samuel Allison reviewed the British report and argued that the British data was not reassuring. Furman, in his March 7, 1944 report to Groves, concluded that "the pretense of study and research as usual has been an enemy security policy but that a great deal of work other than the normal research is evidently taking place." Similarly, chemist Karl Cohen argued in his March 27, 1944 report that "[The enemy's] publishing program on [Liquid Thermal Diffusion] is deliberately designed to mislead us." Furman and Cohen thus saw the lack of publication as indication of subterfuge, rather than as evidence of normality. Cohen also created a highly speculative history of the German program, leading up to the production of an atomic weapon in the spring of 1945. His collaborator Urey, by contrast, was more skeptical that they had made so much progress.[2]

In addition to speculation from the literature, the US program also attempted to detect a German program by technical means: water was sampled from the Rhine in September 1944 to check for radioactive isotopes; flights over Germany attempted to detect the presence of Xenon-133, a radioactive noble gas byproduct of fission; aerial photographs were scrutinized for possible U-

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[1]Richelson 2006, pp. 19-61

[2]On Compton, see 30; on the British report, see 31-32; on Furman's reaction, see 43; on Morrison's assessment, 42; on Allison, 43; quote by Furman, 44; quote by Cohen, 45. All pages in Richelson 2006

235 separation facilities; and captured documents from the program found in Strasbourg were pored over. None of these detection attempts indicated any German progress: the water turned out negative (although a bottle of French wine that accompanied the water was found to be radioactive); no Xenon-133 was found in the filters carried by the aircraft; the only suspected separation facilities turned out to be for transforming oil shale into oil; and the documents indicated that little progress had been made. Despite all of this evidence, which seemed to confirm the British assessment (and Compton's analysis), in December of 1944 former Red Sox catcher and OSS operative Moe Berg was sent to assassinate Werner Heisenberg, the presumed head of the German program; he was to "listen carefully to Heisenberg's remarks, and if he became convinced that the Germans were close to an atomic bomb, to shoot him while he was still in the auditorium." While the lack of a centralized mechanism for intelligence assessment exemplified later by the National Intelligence Estimates makes difficult a precise evaluation of US knowledge of the German program, the assassination assignment, coupled with Furman's suspicion that the German publication patterns indicated withholding (despite the fact that the immense US program had no equivalent "fake publication" effort and would never have let the head of its bomb program travel freely as Heisenberg did), indicates that US intelligence badly overestimated the progress the German program had made by the end of 1944.[3]

This overestimate supports four hypotheses. Politically, resources for collection were initially minimal, and so the inability to collect information (H2b) contributed to the overestimate. Culturally, beliefs about the abilities of the German scientists and a motivated misinterpretation of the slightly delayed publications where absence of evidence was considered evidence also contributed to distortion (H4-5), as did the fact that the nations were at war (H2a). Organizationally, although there were not multiple agencies (H7), multiple different estimates, combined with the bias of the head of the bureaucracy led to domination of the more pessimistic view over the moderate voices.

Soviet Union, 1945-1949[4]

While the US information services had received information on most of the major Soviet nuclear installations, estimates of the program showed serious difficulty. The absence of satellite imagery and reliance on weak HUMINT (human intelligence) against an exceptionally secretive program contributed to the uncertainty, though poor collection is not entirely to blame: various other troubles plagued the analytical process. For one, the first finished analysis on the Soviet nuclear program was produced in October of 1946, after the atomic explosions in Japan. Yet top Soviet scientists had begun to conduct nuclear research as early as 1939. The assumption that the program began after the success of its American counterpart remained unchallenged by analysts and continued to bias estimates until the explosion of the first weapon in August 1949. Additionally, Steury has noted that the original ORE estimate from October of 1946, which was compiled on "very little evidence," went fundamentally unrevised until the first test.[5] Its prediction that the first weapon was "almost certain" to be after 1950 and more likely after 1953 became more precise but hardly more accurate: in July 1949, the month before the first Soviet

[3]On the Rhine water, see 55; on Xenon and the photos, see 49-50; on the documents, see 56; on the assassination attempt, see 50-51, all pages in Richelson 2006. On the lack of a US program, see Powers 2000, p. 285

[4]Richelson 2006, pp. 63-77

[5]Steury 2005

test and two months after a functional weapon had been assembled, Director of Central Intelligence Hillenkoeter informed President Truman that a bomb was "remotely possible" by mid-1950 but most probable by mid-1953. Indeed, this was the same estimate he had given the year before.[6]

This stagnation occurred in the face of sparse but persuasive evidence to suggest the program was more advanced than previously thought. Most notably, information on the amount of tellingly pure calcium traced to the nuclear program should have accelerated estimates; also, it was believed in the United States that the quantity of uranium ore mined was hampering the program, but some information should have provided indications that supplies were more than adequate.[7]

The 1946 estimate, which tempered subsequent experience, was derived primarily by extrapolating from American and German experiences and accounting for Russian industrial capacities. "This approach," writes Steury, "was not a good fit." It fails to allow for outside influence in the form of extensive espionage, declassified literature, and the enormous benefit from captured German scientists,[8] let alone an unexpectedly early start date.

These difficulties correspond to five hypotheses. First, the demands of WWII and the novelty of the Manhattan Project probably deflected attention away from early Soviet activities (H1). Second, this neglect represents a misinterpretation of Soviet intentions (H5). Third, outside assistance was a major benefactor of the Russian program and US intelligence misinterpreted both the tremendous effect of German scientists and the benefits received from espionage against the United States (H6). Fourth, with regard to uranium mining at Joachimsthal, contradictory evidence was never fully resolved (H9). Fifth, and probably most importantly, analysts did not update obsolete estimates, while extrapolation from German and American programs did not lend accurate results in the face of outside assistance and a mistaken start date (H12).

France, 1946-1960[9]

Overall, US intelligence collection regarding the French nuclear weapons program was exemplary. A wide range of human and technological sources allowed analysts to identify and track major scientists, facilities, and methods of the French effort. Partly driven by fears of proliferation of knowledge, information was prepared on French research into nuclear energy as early as 1946. A decade later, comprehensive and accurate assessments were made of fuels procurement, industry, and the future course of the program and detailed information on all planned or existing facilities was available.[10] The first dedicated document, produced the year before the first French test, discusses planned and existing facilities as well as impressive details of the procedures at the Marcoule Chemical Separation Plant, noting the use of the solvent TPB and the production of plutonium as an oxalate salt.[11]

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[6]Holloway 1996, p. 220
[7]Steury 2005
[8]Steury 2005
[9]Richelson 2006, pp. 195-206
[10]Office of Strategic Intelligence 1956
[11]Office of Strategic Intelligence 1959, p. 4

However, intelligence analysts had difficulty converting this intelligence to an accurate bottom line. CIA estimates placed the first French test two years early–hardly a fatal discrepancy, but enough that significant effort was expended in the intervening time to explain the reveal. The discrepancy seems to result from a combination of three factors: the first was unpredicted technical difficulties during the separation and purification stages; the second derives from an underestimate of the attempted yield of the first test: the 60-70 kiloton blast was three times that expected and accordingly required more plutonium, which in turn required more time. The third biasing factor results from uneven data collection during the 1950s. The first U-2 overflight of French facilities did not occur until after the original projected test date, in 1959. This imagery was then combined with that from commercial airliners whose routes would take them over Marcoule.[12]

Not surprisingly given the level of knowledge, the hypotheses active for the French program are relatively minor and result from friendly bilateral relations. First, the friendly French-US relationship and the unlikelihood of preventive action probably prevented aggressive intelligence gathering (H2). Additionally, it is likely that cultural biases were positive in the French case, causing analysts to downplay the probability of inevitable problems and pushing estimates forward (H4). Also, assumptions about the yield of the first test were simply carried from earlier experiences and probably shifted estimates slightly forward (H12).

China, 1955-1964[13]

Despite providing the US political leadership with accurate warning of the initial Chinese nuclear test, the assessments of the intelligence community suffered from serious problems. The major failure originated in the assumption that the Chinese would follow the plutonium path to their first bomb; the device that was exploded in October 1964 used uranium. This error might have been corrected earlier had imagery analysts correctly interpreted the data from the Lanzhou Gaseous Diffusion Plant that eventually produced that highly enriched uranium; instead, the facility was consistently considered incomplete, unpowered, and too small to house the necessary machinery.[14]

Early National Intelligence Estimates of the Chinese program before 1960 seriously underestimated the resolve and capabilities of the Chinese program, while overestimating Soviet support. When this moderate support was withdrawn that year, Beijing made the tremendous diversions of scarce resources to continue the program that analysts thought unlikely. Subsequent estimates better appreciated the seriousness of the effort, but difficulties identifying and evaluating facilities still remained: the plutonium for the initial bomb was meant to come from a nonexistent reactor at the Baotou uranium hexafluoride plant, while other major mining and refining sites went unidentified until late in the game. The expected date of a test was pushed gradually back and was considered possible by the time the test actually occurred (but was more likely later in the year); the US estimate of the route actually taken to produce the bomb was at least three years too late. These failures resulted in a self-conscious estimate in August of 1964 considering the chances of an imminent test based on accurate satellite imagery showing preparation of the Lop Nur testing range. Despite these preparations, analysts could not

[12]Richelson 2006, p. 204
[13]Richelson 2006, pp. 137-167
[14]This difficulty remains unexplained in publicly available sources

confidently assess the means by which the bomb to be tested had been produced.[15]

Given the Kennedy administration's preoccupation with the prospect of a Chinese nuclear test and its consideration of preventive action, analysts operating without sufficient information may have opted to overstate the program to keep policy options open and to avoid surprise. While the White House demanded frequent information and McGeorge Bundy told DCI McCone that Cuba and the Chinese program were the "two issues foremost in the minds of the highest authority and therefore should be treated accordingly by CIA,"[16] estimates consistently outpaced evidence.

These major misunderstandings represent the impact of six hypotheses. First, existing and proposed policy probably influenced estimates: tense relations with the communist bloc made surveillance particularly difficult, while the prospect of major action may have caused analysts to push estimates forward beyond the available evidence (H2). The major action contemplated was the result of a highly concerned President Kennedy and the Joint Chiefs of Staff (JCS); this alarmist ideology may have served to accelerate estimates of the nonexistent plutonium program (H1). Third, underestimation of native Chinese production capabilities was a major factor in skewing earlier estimates, which expected reliance on Soviet assistance (H4). Certainly, too, the intent and resolve of the Chinese Communist leadership to divert resources from economic initiatives was a major factor (H5). Outside sources also played a large role: Soviet assistance was somewhat overestimated prior to 1960, but the real misstep was in failing to detect the extent of Chinese espionage against the United States (H6). In the end, perhaps the most serious failing was in the inability to contemplate a uranium enrichment program, which was probably the result of mistaken induction from the Soviet and American experience (H12).

Israel, 1957-1969[17]

U.S. intelligence estimates of Israel's nuclear program were late and of poor quality. Though Israel began producing the sensitive materials necessary to start nuclear research in 1950[18] and began close cooperation with French nuclear scientists in 1956, it was not until 1960 that American policymakers were made aware of Israel's progress toward a bomb. Had any number of pieces of information been examined in those four years, U.S. policymakers would have had knowledge about the program sooner. In 1957, the year Israel broke ground on the Dimona reactor complex in the Negev desert, Israel also abandoned its request for an American 10 MWth reactor and accepted instead a small Soreq research reactor. This did not arouse suspicion at the CIA.[19] Israel accepted this shift because it had received the nuclear assistance it needed from France in the form of a 18 MWth thermal research reactor and plutonium separation technology the same year. French contractors would later assist with construction at Dimona. In 1958, U.S. analysts received U-2 imagery of Israel's primary nuclear facility at Dimona in the Negev desert, two years after the construction was started. This same year, the intelligence community urged U.S. Atomic Energy Commission and the Department of States to step up collection efforts

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[15]Director of Central Intelligence 1964a

[16]Richelson 2006, p. 12

[17]Richelson 2006, pp. 236-243,247-265,270-273,360-367

[18] In 1956, Israel requested 10 tons of heavy water from the AEC but later abandoned the request; this information was not transmitted to the intelligence community. Director of Central Intelligence 1961c, p. 8.

[19] Cohen 1998, p. 81.

against countries seeking nuclear weapons, but Israel was not included as a country of interest.[20]

In March and April 1958, State Department officials conducted a series of interviews with Dr. Ernst Bergmann, the head of the Israel Atomic Energy Commission and major proponent of the bomb program at the behest of U.S. intelligence agencies. He seems to have been uniformly taken at his word, except for his admission that his country was planning to build a research reactor (which these agencies assumed meant the U.S. reactor).[21] In mid-1959, information on the Dimona complex was furnished to the CIA by human intelligence sources "but was discounted because the other information in the item was demonstrably untrue."[22] Between August and December 1960, a broad range of information finally became available to U.S. intelligence agencies. The decisive piece of information came when University of Michigan nuclear scientist Henry Gomberg was debriefed at the State Department in December about a recent trip to Israel during which he gleaned enough information to guess accurately at the contours and intent of the Israeli program.[23]

Though the Israeli leadership intended to maintain strict secrecy regarding the program a relatively large quantity of information leaked out all the same, which was mostly ignored by U.S. intelligence agencies. Had they launched a concerted collection effort, more surely could have been shaken loose and the program could have been discovered earlier. The failure is doubly grave considering the fact that U.S. intelligence agencies were tracking French nuclear scientists in the run-up to that country's 1960 test in the Sahara.[24]

After 1960, both the Israeli nuclear program and US estimates of it were increasingly enveloped in secrecy. However, we know enough to posit that Israel achieved preliminary nuclear capability in November of 1966 when nuclear scientists recorded the successful completion of a 'decisive test'–possibly a zero-yield trial.[25] Israel may have cemented this by assembling one or more weapons following Egypt's attack during the Six-Day War. Whether or not this account is to be accepted as accurate, the American apprehension of the program is somewhat confused. In September of 1961, nine months after a post-mortem was completed on the American failure to discover the program sooner and an alarmed President Kennedy demanded information, the intelligence community included Israel in a National Intelligence Estimate that surveyed the nuclear capabilities of non-Soviet countries. This accurately concluded that Israel could assemble an explosive device in 1965-66.[26] In fact, there is reason to believe that American intelligence continued to underestimate Dimona's capacity even after discovering the facility, though the incomplete body of the best current open-source knowledge cannot allow us to be sure. NIE 4-3-61 accepted French and Israeli statements at face value and assessed the Dimona reactor as a 26 MWth heavy water unit. Open source data cannot decisively reject this hypothesis, but it also offers very strong reasons to believe that Dimona was at least a 40 MWth reactor from the start. The evidence for the higher estimate comes from debriefed French contractors who noticed both

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[20] Director of Central Intelligence 1961c, p. 7.
[21] Director of Central Intelligence 1961c, p. 10.
[22] Director of Central Intelligence 1961c**,** p. 8.
[23] Cohen 1998, p. 87.
[24] Office of Strategic Intelligence 1956, pp. 39-43.
[25] Cohen 1998, pp. 231-232.
[26] Director of Central Intelligence 1961a, p.2.

reactor power and cooling ducts several times too large for a 24 MWth reactor. Information on plutonium output from the defector Mordechai Vanunu and other sources suggests that the reactor had been running at 70 MWth for its entire lifetime. Looking at all the available open-source information, Albright, Berkhout, and Walker conclude that 40-70 MWth is the likeliest option.[27]

Following this and pressure from the Kennedy administration, Ben Gurion agreed to allow American inspectors to visit Dimona in the week of May 15, 1961. These visits were relatively informal, cordial, conducted by AEC scientists without access to intelligence, and so were unsurprisingly uninformative.[28] Seven more inspections over the next decade revealed similar results.[29] Most official estimates from this period remain classified; there is some anecdotal evidence to suggest that formal estimates during this period and after were eschewed due of the sensitivity of the subject in favor of informal conversations between JAEIC members.[30] This almost certainly did nothing to satisfy the post-mortem's recommendation of diminished viscosity of shared information.

By the time Nixon came to office, ambiguity remained regarding both America's knowledge of the Israeli program and its policy toward it. Johnson's tacit opposition to the program had not carried the weight of Kennedy's disapproval, who once threatened Ben Gurion that further stonewalling on the issue would "jeopardize American commitment to Israel's security and well being."[31] A 1968 State Department memo still asserted that Israel had "not embarked on a program to produce a nuclear weapon."[32] National Security Advsior Henry Kissinger convened NSSM 40, a policy planning board—though without the input of the Arms Control and Disarmament Agency (ACDA) and the Atomic Energy Commission (AEC)—to recommend to the president a position on Israeli nuclear weapons. Howver, by the time Nixon met with Israeli Foreign Minister Golda Meir in the Oval Office in September 1969, preparatory estimates from all sources had assessed the nuclear-capable Jericho missiles and the Plumbat uranium affair and concluded that a bomb had likely already been produced. It seems likely that Meir and Nixon discussed the program openly at that meeting, though its contents have never been divulged.[33] It should be noted that many observers think that American intelligence estimates afterward did not improve and that Mordechai Vanunu's assertions of Dimona's upgrade and increased production caught many in the intelligence community by surprise, though the present level of declassification cannot verify this and in any case these estimates fall beyond the scope of this study.

The CIA's failure in the late 1950s to properly identify Israel's reactor complex at Dimona resulted, like most intelligence failures, from multiple overlapping distortions. The primary problem was that intelligence agencies attached too little importance attached to evaluating and aggregating data about Dimona and Israel's program more generally. The overwhelming quantity

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[27] Albright, Berkhout, and Walker 1997, pp. 257-262.
[28] Cohen 1998, p. 107.
[29] Cohen 1998, pp. 175-194.
[30] Richelson 2006, p. 265.
[31] Cohen 1998, p. 193.
[32] Cohen and Burr 2006, p. 2.
[33] Cohen and Burr 2006.

of information that became available to the Joint Atomic Energy Intelligence Committee (JAEIC) in the second and third weeks of December 1960 suggests that had similar attention been devoted to the Dimona installation at an earlier period in its development, many of these clues would have become apparent.[34] Israel was not prominently discussed in a 1957 NIE of nuclear proliferation and was only listed in the lowest possible priority for intelligence collection the year before; a year later, Israel's program was raised to Second Category. This meant that as late as 1961 all analysis on the Israeli program was "performed on a part-time basis by one intelligence analyst… who is responsible for corresponding coverage of over forty Bloc and Non-Bloc countries."[35] The CIA's own post-mortem on its Special National Intelligence Estimate of 1960 declared that "the second priority status of Israel tended to reduce the effort and urgency attributed to this program."[36] Instead, the accidental discovery of the site by U-2 in 1958 was not confirmed until two years after the fact.

The close relations of the Israeli and American governments was likely a major impediment to accurate analysis and probably contributed to a failure to fully appreciate the warning signs at every level of government. Political will therefore crucially important: it is hard to imagine Kennedy exhibiting a reaction similar to Eisenhower's apathy at being shown preliminary imagery of the site;[37] and a demand for further information could have led to the site's discovery two years earlier. Furthermore, there is some evidence that analysts and policymakers alike assumed that the program could not be completed without US knowledge or assistance; French and Israeli statements regarding their collaboration were accepted at face value, a lenience that would have been inconceivable in evaluating Sino-Soviet interactions.[38] The result of these conditions was that positive data was not recognized in the usual data noise, particularly because reports were rarely distributed adequately. (H2)

The US experience with the Israeli program is unique in a number of ways; this is reflected in six other operative hypotheses. Especially after 1961 and during the NSSM 40 process, the close bilateral relationship uniquely hindered the estimating process, as fear of disclosure prevented the production of formal or interagency NIEs (H3). Next, analysts underestimated Israeli technical capabilities, as it was believed that Dimona could not be completed without US or French assistance (H4). The SNIE noted that "the belief that any such aid would be readily known to the US led to a tendency to discount rumors of Israeli reactor construction and French collaboration…"[39] Early complacency led to a major underestimation of Israeli intent and resolve (H5). As noted, French assistance to the program was much more extensive than expected by US estimates, as statements were taken more or less at face value (H6). While the US community possessed much of the data that could have warned policymakers of Dimona's existence years earlier, much of it went unappreciated and unanalyzed as the result of insufficient transmission or recognition of importance (H8, H9).[40]

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[34] Director of Central Intelligence 1961c, pp. 7-8.
[35] Director of Central Intelligence 1961c, p. 5.
[36] Director of Central Intelligence 1961c, p. 2.
[37] Cohen 1998, p. 84.
[38] Director of Central Intelligence 1961c, p. 2.
[39] Director of Central Intelligence 1961c, p. 2-3.
[40] Cohen 1988, p. 84.

India, 1958-1974[41]

American intelligence overestimated the Indian program, but the distortions were neither critical nor probably preventable given the Indian program and its structure. The major failing lies in the CIA's inability to warn policymakers of the 1974 test in the weeks beforehand. The two difficulties are only partially related.

The overestimation of Indian program is one that is possible to discern only in retrospect: information on the program was excellent and well-used; indeed, the overestimate is on par with that committed by the most knowledgeable officials in the Indian government and policy circles, including Homi Bhabha, Chairman of the AEC, and Prime Ministers Nehru, Shastri, and Gandhi. American intelligence exhibited a persistent uncertainty about the intentions of political leaders; however, this evolved not from poor information but, conversely, accurate information about an uncertain political process. As a result, intelligence estimators were careful to qualify estimates in relation to a future date a decision would be taken to build weapons. Accordingly, he early NIE 4-2-61 predicted that a weapon would be possible in 1968-9 but that authorization from Nehru was unlikely.[42] The moral reluctance to develop weapons declined only gradually among the Indian leadership, from the nonviolent, energy-oriented Nehru, through Shastri, who compromised on PNEs only vaguely and at tremendous pressure, and Indira Gandhi, who eventually permitted a test.

The decisive 1965 SNIE was the first warning to American intelligence consumers that the Indian program was capable of constructing a device quickly, "and could explode it about a year after a decision to develop one." However, the estimate would suggest that Shastri was capable of maintaining his nonnuclear stance against hawkish opposition, though not indefinitely. An explosion, analysts believed, would occur "within the next few years."[43] This political analysis was surprisingly accurate: Shastri was not forced to develop weapons, though he did permit tacitly development of 'peaceful explosives' to mollify domestic pressure.[44] The estimate did give short shrift to the technical travails that lay ahead of Indian scientists in designing a weapon, but it should be noted that this misconception was widespread in the Indian debate and though the SNIE noted that it had received "no evidence that such activities are well advanced," even Bhabha and other scientists believed the remaining difficulties to be marginal.[45] Perkovich notes that Bhabha's claim that a bomb could be produced in 18 months belies a lack of the "design knowledge and the technology required even to make an informed estimate of the cost and time required for India to produce a device."[46] It is likely that analysts' 'at any time' warning was meant as a prudent measure to prevent severe surprise more than as an accurate assessment.

Following the October SNIE, the sudden deaths of Bhabha and Shastri upset the Indian program. The appointed AEC Chairman Sarabhai opposed the development of weapons and would officially terminate development, though calculations and other preparations would proceed at the Bhaba Atomic Research Center (BARC). This pattern of unauthorized but tacitly permitted

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[41]Richelson 2006, pp. 218-235
[42]Director of Central Intelligence 1961b
[43]Director of Central Intelligence 1965, p. 1
[44]Perkovich 1999, p. 82
[45]Perkovich 1999, p. 71
[46]Perkovich 2000, p. PAGE??

development continued into Gandhi's tenure and was ultimately legitimized in her official disavowal of weapons production accompanied by a promise of continued technical progress toward a later decision. This implicitly sanctioned, halting progress makes a specific authorization of weapons production difficult to identify, though Perkovich speculates that various supportive decisions were made between Gandhi's office and BARC scientists in late 1971 and 1972 without consultation of the cabinet or parliament. The difficulty historians have in piercing the inordinate secrecy and ambiguity with which the decision was taken highlights the CIA's difficulty.

However, the CIA's failure to issue warning of the 1974 test remains a failure: satellite imagery of the Pokhran site that betrayed signs of unusual activity went unanalyzed before the test, and the declassified executive summary of an unreleased post-mortem on the intelligence effort alludes to insufficient attention and inadequate communication between elements of the intelligence community. But at the same time, Indian nuclear scientists went to unprecedented lengths to conceal the nature of their efforts from American spies and satellites, conducting a vigorous counterintelligence campaign and moderating behavior at the Pokhran site to minimize satellite coverage; the program was similarly invisible to prominent Indian cabinet ministers from whom it was concealed. The peculiar Indian program proved uniquely difficult to assess: its combination of civilian staff, tacit support, and halting development conducted alternately in extraordinary secrecy and total openness played to intelligence weaknesses and put the burden of detection on human intelligence or protracted satellite coverage, neither of which was likely. Some hypotheses are visibly operative, but without full access to the 1974 post-mortem, the likeliest determination is that the peculiar quality of the Indian program did more to hinder intelligence efforts than any concrete failure.

In addition to the obvious difficulty in analyzing a program that could barely analyze itself properly, three hypothesized distortions play into US estimates. First, not enough attention was paid to imagery already collected from India to provide warning of its nuclear test (H2). Second, the JAEIC post-mortem asserted that some useful intelligence was not properly disseminated through the intelligence bureaucracy (H8). Lastly, it is reasonable to conclude that the US and India both overestimated the readiness of the Indian program in part because previous programs had been held back by material deficiencies rather than design difficulties–in other words, most countries were ready to test when the material was ready, whereas Indian scientists' last hurdle was design challenges (H12).

Taiwan, 1965-1976 and 1987-1988[47]

Prior to the Chinese nuclear test in 1964, NIE 43-64 posited that "Even the detonation of a nuclear device by the Chinese Communists would probably not change things greatly.... [the government] might make a request for nuclear weapons."[48] The October nuclear test by the Chinese seemed to make only minor adjustments to the CIA's estimates; even by 1966, the CIA estimated in NIE 4-66 that only India would be "likely to undertake a nuclear weapons program in the next several years."[49] Yet the same year, the US became aware that Taiwanese scientists had made an unsuccessful trip to Israel seeking nuclear materials and that the Taiwanese military

[47]Richelson 2006, pp. 245-247, 262-263, 266-271, 274-277, 367-368
[48]Director of Central Intelligence 1964b, p. 5
[49]Director of Central Intelligence 1966

were looking into a pilot reactor; furthermore, the US Embassy in Taipei believed that the Taiwanese government was seeking nuclear weapons, although this was rejected by the State Department.[50] The next year, the Taiwanese defense ministry suggested a $140 million proposal to develop nuclear weapons as a response to China's nuclear testing, including a heavy-water reactor, a heavy-water production plant, and a plutonium separation plant. Clearly, to this point the CIA and the State Department underestimated Taiwan's nuclear ambitions.

In 1969, Taiwan ordered a 40 megawatt thermal (MWth) heavy-water reactor from Canada (the same model as the Cirus reactor in India) that started operations in 1973. It produced 15 kg by the end of 1975 and 30 kg by the end of 1978. Construction on a facility with a single hot-cell next to the reactor (the 'Hot Laboratory') was started in 1970 and was due to be completed in 1976; larger-scale reprocessing facilities were sought from the United States, but were vetoed in 1969 by President Nixon. Consequently, Taiwan sought a plant from France or West Germany instead. The US government pressured both Taiwan and West Germany to cancel the facility, which the West German company did in 1973. Nonetheless, a small facility with four gloveboxes (the 'Plutonium Fuel Chemistry Laboratory') capable of producing plutonium metal was constructed by a French company and was operational by 1975.[51]

In 1974, a general CIA estimate noted that "Taipei conducts its small nuclear program with a weapon option clearly in mind, and it will be in a position to fabricate a nuclear device after five years or so.... Its decisions will be much influenced by US policies..."[52] The United States withdrew its nuclear weapons from Taiwan that year, potentially increasing Taiwan's motivations for its own weapons. By 1976, ten fuel rods with about 500 g of plutonium metal had gone missing.[53] The United States asked for, and received, a promise that Taiwan would renounce nuclear weapons development, a promise that was echoed publicly.[54] However, suspicions that a program still continued clandestinely led the US to pressure Taiwan into temporarily shutting down its reactor so that the fuel rods could be scanned by Los Alamos technicians and dismantling its reprocessing capabilities. US suspicions appeared accurate at this point; the discovery of a hidden gate in the spent fuel pool and missing plutonium pointed correctly to continued Taiwanese nuclear ambitions.[55]

Later estimates that appear to discuss Taiwan's nuclear program are often blacked out; for example, a 1985 overview of proliferation blanked out what appears to be a discussion of Taiwan along with Argentina and Brazil,[56] although Taiwan is mentioned in passing elsewhere in the document. Consequently, it is difficult to determine the state of knowledge in the CIA and other intelligence agencies after the 1970s. However, one incident is well-known: in 1987, President Chiang Ching-kuo decided to build another reprocessing facility. The deputy director of the program, Col. Chang Hsien-yi, reported its existence to the United States, which then pressured Taiwan into dismantling the new plant. Additionally, the reactor was shut down in 1988,

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[50]Burr 1999, pp. Documents 1-2, 5, 8, and 11
[51]Albright and Gay 1998
[52]Poor 1974
[53]Albright and Gay 1998
[54]Burr 1999
[55]Albright and Gay 1998
[56]Director of Central Intelligence 1985d, p. 8

ostensibly for conversion to a light-water reactor, after the US suspended shipments of heavy water.[57]

The US initially underestimated Taiwan's resolve and therefore disregarded evidence that it was developing a nuclear weapons program (H5), but later corrected this mistake and successfully managed to halt the program before it progressed very far. Support for Taiwan and a commitment to defend it may have contributed towards the lack of belief regarding Taiwan's nuclear program (H2). The State Department rejected warnings from its embassy in Taipei based on arguments regarding the utility of nuclear weapons for Taiwan rather than based on contrary evidence (H8).

South Africa, 1969-1990[58]

US intelligence of the South African nuclear weapons program was persistently riddled with misunderstandings. Much of analysts' early information was gathered from public announcements and releases; it was only after the crisis in 1977 that a concerted effort was made to acquire detailed information.

Like the Indian program, the organization of the South African program made it a difficult intelligence target. All fissile production facilities were publicly declared and relatively transparent, leaving the bulk of the intelligence work to be conducted on the clandestine design work and inscrutable political considerations. The critical period from 1971-4 in which the political leadership and scientists moved toward designing and constructing a device went largely unnoticed. Accordingly, a 1974 assessment did not consider a South African bomb a serious threat: if the Valindaba uranium enrichment plant could recycle its loads to produce HEU (highly enriched uranium), the necessary fissile material could be produced "within a decade." However, analysts asserted that South Africa "[lacked] all other facilities necessary," underestimating the extensive design work already conducted at the Somchem propulsion laboratory. Political analysis was also flawed: a September 1974 SNIE ascertained no serious threat to South Africa that would compel its leadership to approve weapons; but on the way to that approval, South African military leaders were citing just such a threat from China and Angola. Two years later, a brief article detected no further evidence of a weapons program.[59]

Technical and facilities estimates were little better. The centerpiece of the program, the Valindaba uranium enrichment plant, was the subject of extensive and highly technical analyses, much of which was speculation over the Afrikaaners' unique enrichment technique. However, analysts significantly overestimated the capabilities of the plant, asserting that the plant's output was enough to produce several devices each year, when in fact the products would be produced no faster than one every eighteen months.

Following the 1977 crisis, in which most industrialized countries applied pressure to South Africa to prevent an incipient test, US intelligence filled in many of the gaps in its understanding of the history and the prospects of the program. However, Richelson notes that 1979 assessments of the Vela event that consider South Africa to have produced the device that created the test

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[57]Albright and Gay 1998
[58]Richelson 2006, pp. 243-245,263-266,270-273,277-282,368-400
[59]Central Intelligence Agency 1976

demonstrate a serious overestimation, though it is possible that the details of neutron bomb signatures may not have reached estimators.[60] By 1983, information compiled from an apparent human agent in the program and other unknown sources filled in many of the gaps in American knowledge, including of the explosives testing prior to 1974.[61] Still, an October 1984 NIE continues to overestimate the Valindaba plant's capacity.[62]

Limited declassified records make evaluation of the intelligence community's performance in preventing surprise somewhat difficult. However, it is reasonable to conclude from the flurry of activity that resulted from Brezhnev's letter in 1977 to verify the claims (an unmarked plane from the defense attache photographed the site and satellites were redirected), that while US reconnaissance satellites had been aware of and monitoring the Kalahari test site, they were surprised by the preparations for the test.

In addition to surprisingly poor collection regarding the Somchem and Circle facilities, two identifiable analytic failures hampered estimates. First, the persistent difficulty of applying enough attention to early or uncertain programs applies to South Africa and some of the critical design and policy shifts of 1971-74 were missed, as well as the aforementioned facilities (H2). Second, much of the nuance of policy shifts within the South African leadership escaped American analysts (H5).

South Korea, 1970-1975[63]

South Korea initiated a nuclear weapons program in the early 1970s; the colorfully-named Weapons Exploitation Committee, set up in 1970, unanimously voted to proceed with the development of nuclear weapons. The ignorance of the US intelligence community regarding this decision is made apparent by the 1972 renewal and amendment of the 1956 Agreement for Cooperation to expand the amount of enriched uranium delivered to South Korea, as well as the September 1974 conclusions to a Special National Intelligence Estimate,[64] which grouped South Korea together with Spain, Iran, Egypt, Pakistan, and Brazil as states that would need at least a decade to develop a weapon. However, the May 18, 1974 Indian test of a "peaceful nuclear explosive" led to instructions to US embassies to search their files for requests by governments for certain items needed for nuclear weapons. The South Korean embassy apparently discovered requests for a "substantial number" of suspect items. This information, combined with an assessment of what "Koreans were studying in the United States and about ostensibly civilian research programs supported by the Korean government" led the US government to correctly conclude that South Korea was seeking nuclear weapons. One report argues that the reprocessing plant that South Korea was seeking from France was one of the last few items required for its program. US pressure led to the cancellation of the French-South Korean deal (unnecessary for South Korea's nuclear infrastructure at that stage). By the end of 1975, South Korea joined the NPT and the South Korean nuclear weapons program had ended.[65] Some observers argue that threats in 1977 indicated new interest in nuclear weapons, but there is no evidence of a

[60]Richelson 2006, p. 367
[61]Director of Central Intelligence 1983c
[62]Director of Central Intelligence 1984b
[63]Richelson 2006
[64]Poor 1974
[65]Gillette 1978, Nixon 1972, Poor 1974, USA Government and ROK Government 1972

governmental decision to reconstitute its efforts.[66]

Existing cooperation with South Korea (like other states) led to a lack of scrutiny and collection (H2a,b) of South Korea's activities until after India's May 18, 1974 test. Additionally, the belief that South Korea's activities were directed exclusively towards peaceful, civilian purposes (H5) helped to reinforce existing policy. The failure (H12) to anticipate the Indian nuclear test in 1974 actually led to the correct conclusion that South Korea was pursuing nuclear weapons.

Libya, 1970-2003[67]

Libya initially sought to purchase nuclear weapons outright starting in 1970; overt attempts to acquire nuclear technology began shortly thereafter, including electromagnets for uranium enrichment from a French firm in 1973, proposed exchanges of technology, money, and materials with the Pakistani program around the same time, and a research reactor from a United States firm in 1974–none of which seem to have succeeded. Libya ratified the NPT in 1975 as part of an agreement with the Soviet Union for a 10-MWt research reactor, which wasn't completed until 1981; a deal for a 440-MWe power reactor collapsed in 1986. Libya also approached India, Belgium, Argentina, and Brazil for assistance of different kinds, none of which were successful.[68]

Although Libya did not merit a mention in the 1974 general assessment,[69] the CIA noted in 1975 in a separate assessment that seeking nuclear weapons was a stated objective of Libya's, but that it would take Libya at least a decade to produce a weapon. A followup study in 1985 noted significant difficulties in the program and concluded that it was highly unlikely that Libya would have a weapons capability within the next decade, and noted efforts to buy a weapon from the Chinese in 1973 and 1976.[70] In 1988, the CIA noted that Libya had not assigned a high priority to its nuclear program for the last decade, and concluded that "if the regime were to decide to develop a nuclear weapons capability, we do not believe that goal could be reached for at least a decade."[71] The same study noted negotiations with Pakistan, Belgium, Argentina, and Brazil. Each of these assessments appeared to be accurate, as Libya's next major attempt did not start until 1995.

According to IAEA reports, Libyan authorities "made a strategic decision to reinvigorate its nuclear activities" in July 1995. Despite massive assistance from the A.Q. Khan network, including receiving twenty pre-assembled P-1 centrifuges, Libya had installed only one 9-machine cascade by April 2002—and never fed any nuclear materials into it. Libya also could not develop the uranium hexafluoride production facilities required to feed the centrifuges.[72] The centrifuges that Libya sent the United States after it gave up its nuclear program did not even

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[66]Engelhardt says that the Ministry of Science and Technology announced plans to build a reprocessing plant (p.32), but he mis-cites Mitchell Reiss, who on p.95 notes that it had simply announced plans to domestically produce nuclear fuel.Engelhardt 1996, Reiss 1988
[67]Richelson 2006, pp. 324-327, 336-337
[68]Richelson 2006, pp. 324-327
[69]Poor 1974
[70]Richelson 2006, pp. 336-337
[71]Central Intelligence Agency 1988, p. 43
[72]IAEA Board of Governors 2004 4-5

have rotors installed.[73] The CIA's twice-yearly reports on weapons of mass destruction between 1996 and 2003 only mention nuclear efforts starting in 2000; the only mention there was of its renewal of talks with Russia for a nuclear power reactor.[74] In 2001, the CIA reported on efforts to obtain dual-use technologies,[75] while the next year it noted a televised speech by Qadhafi in March as evidence of an interest in nuclear weapons.[76]

It is difficult to gauge the seriousness of Libya's program between 1995 and 2003. Libya's program may have been intended only as a bargaining chip rather than as a serious nuclear program; pieces were collected haphazardly, and development proceeded slowly. Libya bought "nuclear technology without actually knowing how it worked." Moreover, the bomb design that Libya acquired from the A.Q. Khan network was too large to fit on any of its ballistic missiles.[77]

The Silberman-Robb commission argued that "The Intelligence Community accurately assessed what nuclear equipment Libya possessed, but it was less successful in judging how Libya could exploit the material," and that its "penetration of the A.Q. Khan proliferation network provided invaluable intelligence on Libya's nuclear efforts." It judged that "analysts generally showed a commendable willingness to question and reconsider their assessments in light of new information; Analysts tracking proliferation program developments sometimes inappropriately equated procurement activity with technical capabilities." Additionally, "Libya's declarations did reveal some surprises that are discussed in the classified report." Estimates that concluded in 2002 that Libya could produce enough highly enriched uranium for a weapon by 2007 were found to be optimistic. The report mentions that analysts believed that Libya was receiving parts from the A.Q. Khan network in 2000. Additionally, the report complimented analysts' switch from skepticism of Libya's ability to implement WMD in 1999 to 'worst-case' analysis in 2001; it was this switch that led to the 2007 estimate of a nuclear weapon.[78]

Although the CIA fairly accurately estimated Libya's capabilities in 1975 and the mid- to late-1980s, a lack of information about assistance from the A.Q. Khan network prior to 2000 led to an underestimation of Libya's capabilities. However, once information was obtained, this shifted over to an overestimation in 2001-2002, which continued until Libya gave up its nuclear program in 2003.

Although for the most part Libya's intent and capabilities were correctly estimated, a few mistakes were still made. Prior views (H4) of Libya's incompetence (although justified) may have contributed to the six-year gap between Libya's decision to seek a nuclear program through assistance from the A.Q. Khan network and the CIA reports of Libyan attempts to acquire materials from abroad. Lack of knowledge of the A.Q. Khan network early on (H6) led to a temporary underestimation of Libya's program. Analysts that equated equipment with ability (H12) overestimated Libya's ability to produce HEU by 2007. However, this may not be the root causal mechanism; the Silberman-Robb report notes a shift in 2001 to worst-case analysis that

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[73]Sanger and Broad 2004
[74]Central Intelligence Agency Nonproliferation Center 2000
[75]Central Intelligence Agency Nonproliferation Center 2001
[76]Central Intelligence Agency Nonproliferation Center 2002a
[77]Crawford 2004
[78]Silberman and Robb 2005, pp. 251-253, 257, 260

parallels the shifts in estimates of North Korea and Iraq. This introduces the possibility that executive ideology (H1) may have been responsible.

Pakistan, 1974-1998[79]

The United States appears to have had excellent information about the Pakistani program through its development up to and including the test at Chagai Hills in 1998 from signals, imagery, and human sources; however, the dates given in estimates for the acquisition of the first device were slightly too early.[80] Part of the difficulty in evaluating these estimates is that, as with Israel, the date of acquisition itself must be estimated: Pakistan only confirmed nuclear weapons capability in the 1990s, however the subatomic tests at Chagai Hills and the reported detection of HEU from the Kahuta enrichment facility in 1986 makes this the most probable date. Both of these developments were detected by US intelligence, and an SNIE produced that year concluded that Pakistan could have a weapon immediately.

The construction and operation of Pakistan's myriad facilities, including the development of a test site, were closely and accurately followed by US intelligence. Good information lead to the accurate conclusion that Pakistan was simultaneously following both paths to a bomb (both plutonium and uranium). While the plutonium path was accurately believed to have obtained the facilities necessary to material production, it was held up by an unwillingness to abrogate IAEA safeguards for the plutonium necessary. The HEU path, dependent on the ERL/KRL facility at Chashma, was accurately estimated at every step of the way and initial HEU production was promptly detected through technical means.

Furthermore, in the run-up to the 1998 tests, satellite imagery provided detailed data on the Chagai Hills test site; the test itself was detected through seismic methods.

That intelligence agencies accurately assessed the Pakistani program[81] is reflected in the fact that evidence of only two of the potential analytic problems is apparent; even these are relatively minor. First, the untitled 1978 CIA report probably underestimated the motivation of A.Q. Khan and the Pakistani government, though these assessments were later corrected (H5). Second, Pakistan's extensive proliferation and procurement network proved very difficult for US intelligence services to track: these links and probably Sino-Pakistani cooperation were misunderstood in the years leading to a test (H6). However, these difficulties in following

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[79]Richelson 2006, pp. 327-332,338-346,433-436

[80]Bureau of Intelligence and Research 1975, Director of Central Intelligence 1978

[81]This analysis is dependent on an acquisition date of 1986. 1986 is the first date for which a design, high explosive testing, and the necessary fissile material were all available. Second, it should be noted that athough this was detected and conveyed by the CIA, the Symington amendment which prevented the US from dealing with a nuclear Pakistan was not invoked until 1990. This means the Reagan administration probably delayed public acknowledgement of Pakistani weapons for political and perhaps ideological reasons, though it appears that this was done consciously; intelligence agencies remained assured of the Pakistani program. The line was drawn at informing Benazir Bhutto of the construction of uranium metal bomb cores by DCI Webster in a 1989 meeting; in May 1990 there was evidence that this had occurred and certification was revoked later that year. No information has been found to suggest that this could not have occurred much earlier.

procurement were offset by good intelligence regarding capabilities on the ground in Pakistan once the equipment was installed.

Argentina, 1974-1990

Through 1990, Argentina had the most advanced nuclear program of any Latin American state and included the region's first power reactor at Atucha (1974) and the first announcement of successful uranium enrichment (1983). It has also been suspected of having a nuclear weapons program. Unlike Brazil, National Intelligence Estimates specific to Argentina have not been declassified; nonetheless, general estimates of nuclear progress are available, and a few particular events stand out as indicators of the US ability to track Argentina's program: a 1974 determination that Argentina would have a weapons production capacity in the early 1980s, and Argentina's surprise announcement of a uranium enrichment capability.

Argentina did not make the CIA's list of eight potential proliferators in 1963;[82] however, unlike Brazil, Argentina also did not make the list of nineteen states included in the Secretary of Defense's estimate of nuclear weapons capabilities the same year.[83] Argentina signed the Treaty of Tlatelolco in 1967, but did not end up ratifying it until 1994. It did warrant a much longer discussion than Brazil in the conclusions to a general 1974 SNIE on nuclear proliferation, which noted that Argentina's program "probably will provide the basis for a nuclear weapons capability in the early 1980s," and a "...strong desire for them in some quarters..." that could lead to an even chance of Argentina joining the nuclear club "in the absence of strong international pressures."[84] A 1974 DIA (Defense Intelligence Agency) publication noted that Argentina was seeking a safeguard-free nuclear program, had adopted a posture similar to India's on the NPT and PNEs, and had selected natural uranium reactors despite their unfavorable economic outlook.[85] At this point, these are overestimates of Argentina's capability and intent to proliferate.

Few available documents after that point discuss Argentina's program directly; the notion that Argentina had a nuclear weapons program was primarily limited to non-governmental sources.[86] However, the November 1983 announcement that Argentina had built a gaseous diffusion plant, according to an administration source, "came as a complete and utter surprise to everyone in the US government," and "represents a startling and dismaying failure of intelligence gathering." While the United States had known of the facility, it was thought that it was a zirconium production plant, although "a rigorous analysis of the CNEA budget should have turned up evidence of this project."[87] IAEA director Hans Blix visited (although not in an inspection capacity) shortly thereafter, and concluded that Argentina could not produce nuclear explosives at that time.[88] The plant suffered several setbacks, including a UF-6 explosion in 1984, and even by 1988, Argentina had to purchase enriched uranium from the Soviet Union. In 1990 it was

[82]Director of Central Intelligence 1963
[83]McNamara 1963, p. 6
[84]Poor 1974
[85]Defence Intelligence Agency 1974, pp. 3,4,7
[86]e.g., Sokolski's written testimony to the Senate Sokolski 1982; see the sources cited in Hymans 2001, pp. fn.1, 153 and fn. 84, 176 and Carasales 1999, pp. fn. 14, 64
[87]Kessler and Knapik 1983
[88]Kessler 1983

unclear the plant it had ever worked at all.[89]

Argentina was noted in the 1985 memo on "The Dynamics of Nuclear Proliferation: Balance of Incentives and Constraints" as being constrained by nonproliferation bureaucracies of supplier governments from importing nuclear enrichment technology; economic setbacks, domestic political changes, technical difficulties, competition between separate efforts to build reprocessing and uranium enrichment facilities, and bureaucratic infighting were seen as having caused delays in completing nuclear facilities in Argentina.[90] Argentina, like Brazil, began including IAEA safeguards as a part of agreements selling nuclear technology to other states.[91] In the final analysis of the document, Argentina's economic problems that had undermined its nuclear program were expected to continue, so that "chances are good that the government will not soon reestablish completion of a reprocessing facility as a high priority." Additionally, the reactor planned to be begun in 1985 was not expected to be finished at a minimum within five to seven years. The document also recognized that the Alfonsin government did not seek PNEs, and was taking steps away from that goal, and although "a covert military faction could conceivably attempt to develop weapons clandestinely," such an attempt was expected to be cancelled by the government.[92] This assessment is in line with the conclusions that the most in-depth studies have drawn about Argentina's nuclear ambitions: they were never military in nature. [[Hymans, 2001, Hymans2001Gauchos;Carasales, 1999, Carasales1999The-So-Called]]

Overall, while the intent of the Argentinian government seemed to be accurately estimated in all three major time periods, the lack of knowledge about the uranium enrichment plant announced in 1983 led to an underestimation of Argentina's actual capabilities in the early 1980s, which was corrected by the mid- to late-1980s. Uncertainty about Argentina's uranium enrichment capabilities probably stemmed from a lack of resources put towards collecting data on how far they had advanced (H2b). Some of the assessments concluded that Argentina's refusal to sign or implement treaties indicated a desire to keep a nuclear weapons option, while domestic political reasons related to resisting American influence may have played a role instead, a potential error related to misunderstanding intent (H5).

Brazil, 1975-1990

In 1963, Brazil made the list of nineteen states included in the Secretary of Defense's estimate of nuclear weapons capabilities, but was assessed as having a low motivation to make a decision, over ten years until its first test, and small or potential resources in all four nuclear categories.[93] It did not make the CIA's list of eight candidates the same year.[94] Brazil signed the Treaty of Tlatelolco in 1967 and ratified it in 1968, but did not waive a provision that called for the treaty to come into force only when all members had ratified the treaty. By 1968, the first available NIE for Brazil accepted Brazil's "sovereign right to develop its nuclear energy resources" as a "favorite nationalist cause" of the Costa e Silva administration, and notes the administration's refusal to refrain from researching PNEs as well as its arguments against the draft NPT since it

[89]Kessler 1984, Kessler 1988, Kessler 1990
[90]Director of Central Intelligence 1985d, pp. 4, 8-10, 13-14
[91]Director of Central Intelligence 1985d, p. 12
[92]Director of Central Intelligence 1985d, p. 16
[93]McNamara 1963, p. 6
[94]Director of Central Intelligence 1963

did not distinguish between nuclear weapons and PNEs.[95] However, a 1974 NIE simply lumped together Brazil with five other countries as needing "at least a decade to carry out a nuclear weapons development problem."[96] A 1974 DOD assessment noted that "Their drive for self-sufficiency... appears at this time to be unrelated to nuclear weapons proliferation aspirations..."[97] A 1975 Brazil-specific NIE stated that although it "has almost certainly not made a decision to develop nuclear weapons, the government does not want to foreclose this option... it regards US pressure to sign the Nuclear Nonproliferation Treaty as an unacceptable infringement of its sovereign rights."[98] "If Brazil were to embark on such an endeavor in the near future using indigenous facilities, it probably could develop a nuclear device by the early 1980s..."[99] Like most estimates with a ten-year timeframe, these estimates are difficult to disprove; however, US intelligence appears to have correctly estimated that the government had not made a decision to develop weapons.

In 1975, Brazil signed a nuclear technology agreement with West Germany that covered all aspects of the nuclear fuel cycle, emphasizing knowledge transfer as well as transfer of physical artifacts.[100] A 1976 State Department report singled out Brazil in Latin America as "one of the most critical areas" due to this attempt to obtain a reprocessing plant from Germany.[101] A 1979 cable from the US Embassy in Brazil to the State Department warned that by the late 1980s that Brazil would have the potential of both producing sensitive nuclear material and exporting that knowledge; at that point, the impediment to proliferation would not be capabilities but a continued political commitment.[102] Presumably this was without knowledge of the parallel PATN nuclear program (Programa Autonomo de Tecnologia Nuclear) started in the late 1970s by the military in response to the official Nuclebras program, which many governmental, military, and civilian personnel thought was too reliant on foreign technology. Every branch of the military had its own nuclear project; the Air Force investigated laser enrichment, the Navy centrifuge enrichment, and the Army a small graphite reactor. While the Army and Air Force projects never progressed very far, the Navy mastered enrichment by 1986, which was announced in September 1987.[103]

By 1983, Brazil's nuclear program merited its own SNIE, which assessed that "Brazil has not made a decision to build nuclear explosives and is not able to commit the resources to do so. It is nonetheless exploring two approaches that could eventually give it the option to produce the nuclear material for a nuclear explosives capability," an unsafeguarded natural uranium reactor that would require construction of a large reprocessing plant, and production of HEU. Either approach was assessed to take at least five years to produce fissile material. However, Brazil "probably could not achieve this objective before the mid-1990s."[104] This estimate discussed

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[95]Director of Central Intelligence 1968, p. 5
[96]Poor 1974, p. 3
[97]Defence Intelligence Agency 1974, p. 16
[98]Director of Central Intelligence 1975, p. 2
[99]Director of Central Intelligence 1975, p. 11
[100]Barletta 1997, pp. 4-5
[101]Livingston 1976, p. 3
[102]Sayre 1979, p. 4
[103]Barletta 1997, pp. 5-6
[104]Director of Central Intelligence 1983a, p. 1

both Nuclebras and the independent civilian IPEN (Instituto de Pesquisas Energeticas e Nucleares), which the military programs collaborated with, but appeared to have no specific knowledge of the military components of the program. Moreover, it emphasized construction of a natural uranium reactor (the Army project) as the best method for Brazil if it were to seek nuclear weapons with an estimated date of 1988-89 for eight kilograms of separated plutonium; however, it did acknowledge the existence of a centrifuge project.[105] These estimates actually underestimated Brazil's capabilities; if, as discussed below, Brazil had the capability to generate HEU by 1990, and the ability to develop a bomb within a month of acquiring the necessary materials, the mid-1990s estimate is too pessimistic. This seems to be primarily due to an overemphasis on the plutonium route combined with the lack of knowledge of the progress of the centrifuge enrichment program.

In 1984, the CIA thought that Brazilian refusal to put parts of its program under safeguards and its resistance to Tlateloco and the NPT "demonstrate a determination on Brazil's part to preserve a nuclear weapons option." The 1984 NIE on prospects for Brazil's regime noted, however, that "There has been some improvement over the last two years or so as the United States has become less concerned that Brazil represents a near-term proliferation threat." [106]With the election of President Neves, a supplement was published that outlined the new President's expected nuclear policy, which was for the most part predicted to be the continuation of existing policies.[107] This proved to be mostly correct, although construction at the Cachimbo site, suspected as a potential nuclear test site, was terminated in 1986.[108]

Meanwhile, Brazil was noted in the 1985 memo on "The Dynamics of Nuclear Proliferation: Balance of Incentives and Constraints" as being constrained by its debt load from importing nuclear technology and the strength of the international norm against developing explosives; economic setbacks, domestic political changes, technical difficulties, military desire to avoid money being diverted from other programs, bureaucratic infighting, and the waning prestige of nuclear (versus space, computing, and bio) technology were seen as having caused delays in completing nuclear facilities in Brazil.[109] Brazil even began including IAEA safeguards as a part of agreements selling nuclear technology.[110] In the final analysis of this document, Brazil was "many years" away from a plutonium capability and might never have ended up enriching uranium on a large scale, although improved economic conditions might have allowed renewed construction on these facilities.[111] In the latter case, the estimate was wrong: work on the industrial-scale site at Aramar began in 1985 and was held up not by any of the listed causes, but rather by protests from local groups.[112] A former president claimed in 2005 that Brazil had had a nuclear weapons program, but only offered as evidence the existence of the same Cachimbo

[105]Director of Central Intelligence 1983a, pp. 9-10
[106]Unfortunately, the remainder of the paragraph remains classified, so it is unclear why Brazil seemed to be less of a threat.Director of Central Intelligence 1984a, p. 27
[107]Director of Central Intelligence 1985a, p. 13
[108]Barletta 1997, p. 11
[109]Director of Central Intelligence 1985d, pp. 3,4,8-10,13-14
[110]Director of Central Intelligence 1985d, p. 12
[111]Director of Central Intelligence 1985d, pp. 14,16,18
[112]Barletta 1997, p. 24

shaft that earlier assessments had determined was ambiguous.[113]

An updated 1985 memorandum to the 1983 SNIE was more alarming, since Argentina's announcement in late 1983 that it had an enrichment capability "has greatly spurred the Brazilians... some military officers apparently believe that Buenos Aires has built, or can now build, nuclear weapons and that Argentina poses a potential military threat to Brazil... We believe that in the long run economic factors will not constrain the Brazilians if they are determined to pursue this indigenous program." However, a date for a nuclear test would be "at least 1990," and the estimate did not believe that the Brazilian government had decided to develop weapons.[114] However, "[t]he current direction of Brazil's national nuclear program, and the prominent role of the military in it, presents a danger to US interests in Brazil."[115] This assessment was also less optimistic about the positive effect of domestic political changes: "The change from a military to a civilian government has not altered these goals."[116] It produced the same date (1990) as previous estimates for a potential nuclear test if an order to produce a weapon were given immediately.[117] Aramar's capabilities at the time were unknown.[118] The Brazilian Physicists Society estimated in 1990 a time of one month from acquiring sufficient materials to testing a weapon.[119] Hence these later estimates of a date around 1990 were probably a little over, despite the lack of concrete knowledge regarding Brazil's centrifuge uranium enrichment capabilities. The last available estimate on Brazil's capabilities were from around 1985, so developments after 1990 cannot be assessed.

Overall, while the intent of the Brazilian government seemed to be accurately estimated in all three major time periods, the lack of knowledge about the fast progress of the uranium enrichment program led to an underestimation of Brazil's actual capabilities in the early 1980s, which was corrected by the mid- to late-1980s. Lack of knowledge of Brazil's HEU program probably stemmed from a lack of resources put towards collecting data on how far they had advanced (H2b). It is unclear whether the later estimate was simply correct by happenstance or whether it was due to different information, although the former seems more likely than the latter. Some of the assessments concluded that Brazil's refusal to sign or implement treaties indicated a desire to keep a nuclear weapons option, while domestic political reasons related to resisting American influence may have played a role instead, a potential error related to misunderstanding intent (H5).

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[113]On the 2005 report, see Olmos 2005; on the earlier debate about the shaft, see Barletta; 1997; Barletta1997The-Military

[114]Director of Central Intelligence 1985b, pp. 1-2

[115]Director of Central Intelligence 1985b, p. 2

[116]Director of Central Intelligence 1985b, p. 3

[117]Director of Central Intelligence 1985b, p. 7

[118] 1992 testimony indicated that Brazil had about 900 centrifuges;Krasno 1994 since Brazil reportedly had developed centrifuges capable of 5 SWU/yrBarletta 1997, p. fn.7, it could have produced about 22 kg of 90 percent U235 per year, assuming a tails assay of 0.3 percent, or about one simple implosion weapon per year. However, other sources indicate that the centrifuges were initially only capable of 1.8 SWU/yr, and that the plant only had about 600 centrifuges by the end of 1990.Albright, Berkhout and Walker 1997, p. 374

[119]Barletta 1997, p. 24

North Korea, 1982-2006[120]

The current Yongbyon site where the bulk of North Korea's nuclear infrastructure sits was started in 1962, when the Soviet Union agreed to supply the Democratic Republic of Korea (DPRK) with a small (2 MWth) IRT-2000 research reactor. In the 1970s; North Korea separated a small amount of plutonium from the fuel rods of this research reactor.[121] North Korea joined the International Atomic Energy Agency in 1974, and placed this research reactor under safeguards in 1978.[122]

In the late 1970s, North Korea began planning to build a 5 MWe graphite-moderated reactor at Yongbyon, which went critical in the mid-1980s. In the mid- to late-1980s, construction was started on a second (50 MWe) graphite-moderated reactor and a plutonium reprocessing facility at the same site; in 1989, construction on a third (200 MWe) graphite-moderated reactor located in another location (Taechon) also began. Additional facilities are known to exist. A reprocessing facility, also located at Yongbyon, was begun in the late 1980s; an earlier pilot facility may have also existed. This facility was intended to have two process lines sufficiently large to reprocess spent fuel for all of North Korea's reactors; at the time of the Agreed Framework in October 1994, one of the lines was almost complete.[123]

In December 1985, the Soviet Union agreed to supply four light-water nuclear power reactors if North Korea joined the Nonproliferation Treaty (NPT). North Korea signed the NPT, but failed to submit a safeguards inspection agreement with the IAEA by the extended deadline of December 1988. In 1989, the DPRK shut down the 5MWe reactor for about 70 days, removing and reprocessing some of the fuel rods and extracting the plutonium. While North Korea claims that it only removed a few damaged fuel rods and reprocessed about 90 g of plutonium, they could have extracted up to several kilograms, depending upon how many fuel rods they removed and the efficiency of the extraction process.[124] In parallel, the DPRK is rumored to have conducted a series of high explosive tests between about 1983 and 1991;[125] further tests were rumored to have occurred between 1991 and 1994.[126]

In 1994, the DPRK again shut down the 5MWe reactor and withdrew the fuel rods from the core. The history of the reactor was partially destroyed by removing the rods without noting where in the core they were placed, making it difficult to reconstruct the operating history of the reactor and therefore the number of fuel rods that the DPRK had withdrawn in 1989. After the threat of economic sanctions and a face-saving trip by former President Jimmy Carter, the US negotiated the Agreed Framework with the North Koreans, shutting down the reactor and preventing reprocessing of the fuel rods removed from it.

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[120] Richelson 2006, pp. 332-333, 346-348, 351, 356-359, 517-537

[121] See Hibbs 1992 and Albright and O'Neill 2000 on this separation, which the North Koreans later admitted.

[122] On the North Korean program from 1945–1980, see Mazarr 1995.

[123] Albright and O'Neill 2000, Bermudez Jr. 1994, Bermudez Jr. 1999a, Bermudez Jr. 1999b, Bermudez Jr. 2002.

[124] On the operating history of the 5MWe reactor and estimates of the plutonium extracted, see Albright and O'Neill 2000.

[125] Nuclear Threat Initiative 2005.

[126] Yu 1996.

The CIA first noted the construction of the 5MWe reactor in 1982, but noted that it "is not designed to produce the quantities of plutonium needed for a nuclear weapons program," and in a separate assessment noted that "We have no basis for believing that the North Koreans have either the facilities or materials necessary to develop and test nuclear weapons." In 1984, the CIA revisited the reactor, judging that it would take at least three more years before it would be complete.[127] In 1985, a general estimate noted that the reactor was capable of producing "significant quantities of plutonium by 1990."[128] Two years later, the CIA issued a report entitled "North Korea: Potential for Nuclear Weapon Development," that called North Korea's efforts "a considerable developing capability." North Korea issued a denial of its weapons aims in 1989.[129] Satellite imagery showed that North Korea was building what appeared to be a reprocessing plant in June 1989.[130] The State Department estimated in 1991 that North Korea would not be able to develop a nuclear weapon until mid-decade,while the Pentagon and the DIA estimated three to five years, and experts at the DOE labs several more.[131]

In February 1992, CIA director Robert Gates estimated that North Korea had only a few months to a couple of years before they would have a nuclear bomb, while the director of the State Department's intelligence arm (INR) Toby Gati argued that North Korea would need two or more years; this difference was attributed by an administration official to the need for the CIA to project worst-case estimates after their underestimation of Iraq, while the official attributed the State Department's focus on diplomacy to its inclination to say that there was still time to solve the problem. Gates' replacement, James Woolsey, stated that North Korea "could have enough nuclear material" for one or maybe two weapons.[132] A separate estimate assessed that "there was more than a 50 percent chance that the country might already possess a very small nuclear arsenal, consisting of one or two bombs,"[133] while the State Department argued that due to reprocessing inefficiencies, the material was likely to be less than what is required for a single weapon. However, the State department had earlier accepted that the reprocessing plant was actually a manufacturing plant. After the Agreed Framework was signed, the DIA argued that North Korea would operate a covert program regardless of agreements, while the INR argued that the North was looking for improved relations.[134]

The variability in intelligence estimates was not simply limited to agency differences. As Pollack notes, most of the CIA estimates were consistent with each other through the 1990s, but in 2001 the intelligence estimates rewrote the past, stating that "[t]he Intelligence Community judged in the mid-1990s that North Korea had produced one, possibly two, nuclear weapons," then that "the US . . . has assessed since the early 1990s that the North has one or possibly two [nuclear] weapons using plutonium it produced prior to 1992."[135]

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[127] Wampler 2003, Documents 1, 2, 4.
[128] Director of Central Intelligence 1985c, p. 17.
[129] Wampler 2003, Document 7.
[130] Richelson 2006, p. 357.
[131] Wampler 2003, Document 15, Mack 1991.
[132] Quoted in Richelson 2006, p. 522
[133] Richelson 2006, p. 523
[134] Richelson 2006, pp. 522-524.
[135] Central Intelligence Agency Nonproliferation Center 2002b, National Intelligence Council

Unfortunately, these estimates cannot be properly assessed. While the assessment of plutonium production and separation is still up for debate, with the differing estimates of the CIA, DIA, and the INR, someone must be wrong. The INR was clearly wrong about the reprocessing plant, but arguments have been made that they were correct about the North's intent in general; while the North did eventually start a HEU program, it was small in scale until at least 2000.[136] Nonetheless, the evidence is somewhat ambiguous.

However, US officials did turn out to be incorrect about one particular suspected facility at Kumchang-ri, where satellite imagery seemed to indicate by the summer of 1998 a major tunneling operation, suspected to be nuclear-related. After negotiations and threats, a team inspected the site in May 1999 and found no indications of nuclear activity; a follow-up visit in 2000 found nothing additional.[137]

Finally, estimates concerning the DPRK HEU program and transfers to and from Pakistan were more-or-less correct. The Clinton administration reportedly learned of transfers between North Korea and Pakistan in 1998 or 1999, according to the Congressional Research Service (CRS).[138] The CIA first mentioned seeking components for uranium enrichment specifically until the latter half of 2001, when it reported that "the North has been seeking centrifuge-related materials in large quantities to support a uranium enrichment program. It also obtained equipment suitable for use in uranium feed and withdrawal systems."[139]

In October 2002, Assistant Secretary of State James Kelly visited North Korea and accused the regime of conducting a clandestine HEU program based on intelligence that indicated that North Korea had sought parts from Russia and had acquired aluminum tubes sufficient for 2600 P2 centrifuge casings, although the latter intelligence did not become publicly available until 2005.[140] A special, untitled report by the CIA, released on November 19, 2002, stated "we assess that North Korea embarked on the effort to develop a centrifuge-based uranium enrichment program about two years ago."[141]

These estimates seemed to be publicly confirmed when a shipment of 214 6000-grade aluminum tubes were intercepted on April 12, 2003, as a French ship sailed through the Suez Canal on their way to North Korea via China. These tubes, unlike the Iraqi tubes, fit very closely dimensions of centrifuge plans that the A.Q. Khan network passed on to North Korea.[142] Musharraf verified in 2005 that A.Q. Khan had passed "probably a dozen" centrifuges to North Korea.[143] Yet, as David Albright has argued, extrapolating the size or even existence of a program from a set of tubes is highly dubious; moreover, an unnamed CIA official in 2004 stated that the CIA was not even

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2001, p. 9, Pollack 2003, p. 12.
[136] Montgomery 2005.
[137] Richelson 2006, pp. 527-529.
[138] Niksch 2005.
[139] Central Intelligence Agency Nonproliferation Center 2001.
[140] International Herald Tribune 2005b, Robbins and Hussain 2002.
[141] Central Intelligence Agency Nonproliferation Center 2002b.
[142] Warrick 2003.
[143] Agence France Presse 2005a.

certain whether that such a plant existed.[144]

Since North Korea ejected IAEA inspectors in late 2002, other than the interception of the aluminum tubes in 2003, no further solid evidence has emerged that could confirm any other estimates regarding North Korea's nuclear capabilities. No specific site has been identified, and CIA estimates remained static, arguing that North Korea "has pursued a uranium enrichment capability at last in the past."[145]

The 2006 North Korean nuclear test is not a satisfactory test of US intelligence simply due to the North Korean decision to announce on October 3 that it would test, followed by the actual test on October 9. The uncertainty that preceded the test as to the location of the potential test site before the test seemed to indicate a lack of sources outside of defectors and satellite imagery, although in the end the site at which vehicle movement and cable reels were spotted (near P'unggye-yok) was correct. Additionally, in 2005 some intelligence officials leaked information to the New York Times regarding preparations being made for a test, which turned out to be false.[146]

The changes noted by Pollack in 2001 and 2002 that re-wrote the history of intelligence estimates potentially indicate (along with the Iraq and Libyan cases) an influence of executive ideology (H1). The HEU intelligence may have been influenced by policy initiatives (H2a); North Korea by October 2002 had already been placed in the Axis of Evil, the Nuclear Posture Review, and the National Security Strategy, all of which characterized North Korea as a belligerent state.[147] Indeed, estimates seem to track policy closely, since the characterization of North Korea's HEU program has been walked back over time in step with a renewed commitment to the Six-Party Talks. Poor ability to penetrate North Korea led to wildly varying estimates from different agencies, at least some of which must be wrong; in particular, as one unnamed administration official noted, State Department estimates seemed to be biased due to their focus on diplomacy (H2b,c). By contrast, the DIA consistently assumed that North Korea would cheat on any agreement, leading to an overestimation of their likely capabilities in the mid-1990s, and to leaks regarding DPRK tests in 2005 (H5). With the high degree of disagreement between the different intelligence agencies, worst-case estimates seemed to prevail at the level of the DCI/DNI (H7). The failure to predict Iraq may have influenced estimates of North Korean capabilities, leading to the overestimation by the DCI of North Korean capabilities in 1992, as the same unnamed official noted (H11).

Iran, 1984-2007[148]

Before the Islamic Revolution, the Shah had an ambitious nuclear program, including up to 20 nuclear power plants providing 23,000 MWe. By the time of the revolution, most of the projects had already been canceled; in the early 1980s, the nuclear program was revived, although it had little direction until the mid-1990s, when Russia agreed to complete the Bushehr reactor, and Iran received two shipments of centrifuge parts from the A.Q. Khan network. Due to IAEA inspections between 2003 and 2005, Iran's capability and acquisition history can be compared to

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[144] Albright 2007.
[145] Central Intelligence Agency Nonproliferation Center 2008, p. 6.
[146] http://www.armscontrolwonk.com/index.php?id=698.
[147] Bush 2002, Department of Defense 2001, National Security Council 2002.
[148] Richelson 2006, pp. 503-517

US assessments.

Iran first merited a mention in a 1974 report as a state that would need at least a decade to develop weapons,[149] an assessment that went virtually unchanged by 1985, when the CIA argued that "there is virtually no chance any of them could reach that level in the next 10 years."[150] In 1988, the CIA concluded that Iran "does not pose a weapons proliferation threat at this time," but would eventually try to develop a nuclear weapons capability.[151]

A scare came in 1991, when numerous reports claimed that Iran purchased three nuclear warheads from Kazakhstan; as a result, a House Republican Research Committee claimed in early 1992 a "98 percent certainty" that Iran had acquired at least two nuclear warheads.[152] The stories turned out to be false, and the supposedly missing warheads were apparently at the bottom of three test shafts at the Semipalatinsk test site.[153] A draft NIE leaked at the end of 1991 "...concluded that Iran's leadership was committed to developing nuclear weapons," but "...was disorganized and only in the first stages of development..." CIA director Robert Gates testified in 1992 that Iran could have a weapon by 2000.[154]

The CIA was correct to have assessed that Iran posed little threat: the effort by Iran to pursue nuclear technology in the 1980s was much less than that taken by Iraq. CSIS analyst Anthony Cordesman notes that estimates of the total number of people working on Iran's nuclear program in the late 1980s was around 500, versus 7500 for Iraq's program, a more typical number for a nuclear weapons program. He argues as well that the manager of the nuclear program, replaced only in 1997, was incompetent.[155] In any case, Gates' estimate was a clear overestimate; by 2000, Iran had made little or no progress with any of the methods of acquiring fissile materials. While this may partially be due to US efforts as a result of the original estimate, this may in large part have been due to a lack of effort on Iran's part.[156]

During the 1990s, concerns about Iran seeking centrifuge technology abroad continued to grow. Around the time of the 1995 crisis with Russia, many predictions surfaced. One senior official noted that "Iran is concentrating on centrifuge designs and looking toward a pilot plant," and likely had plans for "G1 and G2" centrifuges (which turned out to be quite close to the truth, unlike most estimates). Predictions of when Iran would produce a nuclear weapon varied greatly, with the low end predicting a weapon in two to five years. Secretary of Defense William Perry offered two contingencies, one with fissile material (maximum five years), the other without (minimum five years).[157] Secretary of State Warren Christopher in 1995 described Iran's program as a "crash effort to develop nuclear weapons,"[158] while an unnamed official argued that

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[149]Poor 1974
[150]Director of Central Intelligence 1985d, p. 9
[151]Central Intelligence Agency 1988, p. 25
[152]Hedges 1995
[153]1992
[154]Richelson 2006, p. 506
[155]Cordesman 2000, p. 4
[156]Montgomery 2005
[157]Albright 1995
[158]Greenhouse 1995

the time had decreased from ten years to about five years, with two years to acquire the initial materials.[159] Given the problems that Iran has had and the slow rate of development,[160] these constitute overestimates.However, an unclassified CIA report in 1996 argued that "Iranian nuclear-related purchases were not focused on any particular countries and were only indirectly related to nuclear weapons production."[161] John Holum, director of the US Arms Control and Disarmament Agency, predicted in 1997 that Iran would not be able to produce enough fissile material until 2005-2007, versus 2003 two years previously.[162]

In 2000, the CIA radically altered its assessment of Iran, arguing that it could not rule out Iran's development of a bomb simply because it could not reliably track Iran's acquisition.[163] This assessment may simply have been an attempt to compensate for underestimating Iraq's program and the Indian nuclear test in 1998.[164] Yet CIA director George Tenet gave an unusually long timeframe for Iranian acquisition of nuclear weapons in February 2002, predicting proliferation by the end of the decade if Iran received no fissile materials from outside the country.[165] By contrast, Amin Tarzi, an analyst at Monterey, argued that "Iran's [nuclear] program is in shambles, and the people who read all the intelligence know that."[166]

Although the IAEA revealed a great deal of information in 2003 and 2004 about Iran's nuclear program, many of Iran's nuclear activities—in particular, those that involved outside suppliers other than the A.Q. Khan network—were already known to the United States; many of these activities were stopped by US pressure on these suppliers. Three areas of Iran's nuclear program that were previously unknown were revealed by the IAEA: a limited number of clandestine experiments involving uranium conversion and plutonium separation; the extent and progress of Iran's centrifuge program, including the Natanz facilities; and the Arak heavy-water production facility (construction of the Arak reactor only started recently). The facilities began showing up in unclassified reports at the end of 2002.[167] However, most of the other major facilities were already known to the IAEA and the United States.

It is possible that the CIA was aware of some of these facilities, but did not report them in the unclassified reports; while satellites had detected the digging at Natanz, the ordinary appearance of the Arak heavy-water production facility (but not the nuclear plant to be located alongside) kept it from being identified as such.[168] In any case, the amount of time that Iran could take to develop a nuclear weapon can now be estimated; in 2006, David Albright made a worst-case estimate of 2009.[169]

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[159]Hedges 1995
[160]Montgomery 2005
[161]Central Intelligence Agency Nonproliferation Center 1996
[162]Hanley 1997
[163]Risen and Miller 2000
[164]Richelson 2006, p. 510
[165]Gedda 2002
[166]Peterson 2002
[167]Central Intelligence Agency Nonproliferation Center 2002a
[168]Richelson 2006, p. 512
[169]Albright 2006

Consequently, estimates made from 1997 until about 2003 seem to be roughly accurate, with the alarming 2000 estimate by the CIA that it could not verify that Iran did not have a nuclear weapon.

Alarm over Iran's nuclear activities did not accelerate as much as it did for Libya or Iraq, but individual members of the Bush administration and the House Intelligence Committee have overemphasized Iran's intent or progress, placing pressure on intelligence agencies (H1).[170] The Clinton administration's policy of preventing Iran from completing its nuclear power plant at Bushehr has continued, despite a lack of clear pathways to proliferation from the light-water reactor. The US has managed to cut off several attempts by Iran to gain nuclear technology from abroad, but seemed to be unaware of the uranium enrichment facilities at Natanz until an Iranian dissident group publicized the facilities (H2a,b). The later CIA estimates (beginning in 1999) appear to be based on an assumption that Iran is seeking nuclear weapons without any particular indication of additional evidence (H5).[171] Lastly, the extent of assistance from the A.Q. Khan network appeared to be underestimated prior to the IAEA reports (H6).

Iraq(1), 1981-1991[172]

In part because of Iraq's enforcement of strict secrecy surrounding its nuclear weapons effort, including the avoidance of telephones, modification of architectural plans, and compartmentalization, US intelligence sources were plagued by serious misunderstandings of the Iraqi weapons program between 1981 and 1991. However, several failures on the part of organizations and individual analysts allowed Iraqi deception to critically limit US knowledge of the weapons effort. Intelligence agencies appear to have been unaware of some of the most important Iraqi design and production facilities, including the Al Atheer design complex and the Furat centrifuge center, as well as major portions of the procurement effort, including the program to enrich uranium through electromagnetic separation; these and other facts were understood only after revealed by IAEA inspectors.[173]

The analytical missteps began as early as 1981 following Israel's destruction of Iraq's Tammuz-I reactor. While the Iraqi program continued to explore the possibility of securing a reactor from Italy, Brazil, Spain and other sources, scientists also initiated a broad program to enrich uranium. A 1983 assessment by the CIA does not even consider the possibility of the uranium path and instead focuses on the plutonium fuel cycle. When Iraq largely abandoned its search for a foreign reactor in the late eighties, intelligence agencies were left with little or no information about an enrichment program that was advancing on four different technological fronts; indeed, the 1983 estimate admitted "We still see no identifiable nuclear weapon program in Iraq,"[174] a sentiment that was echoed as late as 1989 in a President's Daily Brief.[175]

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[170]Bolton 2004, Mazzetti 2006

[171]Compare the reference to Iran's "nuclear weapons research and developmental program" as if it was certain to exist in Central Intelligence Agency Nonproliferation Center 1999 with the lack of such a phrase in Central Intelligence Agency Nonproliferation Center 1998

[172]Richelson 2006, pp. 318-324, 333-336, 348-356

[173]Richelson 2006, p. 462

[174]Director of Central Intelligence 1983b

[175]Sciolino 1991

This uncertainty about the program allowed for highly variable and politically influenced estimates. The last intelligence estimate prior to the arrival of inspectors probably underestimated the effort, saying indigenously produced fuel could be obtained by the late 1990s, while overestimating the capability of a crash program. It was estimated that by diverting reactor fuel a bomb could be ready "in as little as a few months;"[176] in reality, this program was attempted and most estimates by inspectors give the lower bound as a full year. Albright estimates that the formal program could have produced significant quantities of HEU by 1992 through EMIS and 1995 by centrifuge.[177]

Part of the problem derived from insufficient attention: Richelson notes that prior to the first IAEA inspection team, "There had been no systematic overhead imagery of central Iraq,"[178] while news sources have reported that the CIA had only one analyst assigned to Iraq who also covered Japan; DIA had only two. DCI Gates testified that Iraqi WMDs "were not a high priority for this nation."[179] This contributed to major misunderstandings that included uncertainty about the head of the program (Jaffar Dhia Jaffar was only identified by inspectors, and gradually at that); unidentified and misidentified facilities; and complete failure to detect the EMIS and hydrogen bomb programs, as well as serious ambiguities regarding the gaseous diffusion, centrifuge, and laser enrichment efforts. That Iraq pursued all of these routes at once contributed to the difficulty, but the misunderstanding was so extensive as to impair the course of disarmament following the war, let alone policy preceding it. If Saddam Hussein had not invaded Kuwait it is a distinct possibility that Iraq could have developed a bomb without US knowledge.

These difficulties resulted from five intelligence failures. First, the US's Iraq policy made accurate estimation difficult: not enough analytic capacity was devoted to Iraq prior to war,[180] while the run-up of the Gulf War probably pushed estimates of a crash program forward somewhat (H2). The program's underestimation was driven by a prior underestimation of Iraqi manufacturing capabilities, as evidenced by the expected reliance on foreign sources (H4). Third, analysts' concept of Saddam's intentions were somewhat mistaken: they were correct about his steadfast determination, but underestimated his willingness to pursue diverse technologies through vast investments of resources and personnel (H5). Fourth, in addition to lacking good information regarding foreign assistance to the centrifuge effort, literature declassified by the US regarding calutrons following their retirement from service was unexpectedly useful to Iraqis (H6). Fifth, analysts mistakenly discounted the use of EMIS because of other recent experiences; furthermore, the June 1983 estimate did not contemplate a shift to uranium enrichment from the previous plutonium program (H12).

Iraq(2), 1991-2003[181]

The analytic process surrounding Iraq's nuclear weapons program between 1998 and 2003 was unprecedented in a number of ways. The conclusions reached were uniquely poor and were mirrored by egregious and demonstrable distortions of the ideal national intelligence estimating

[176]Director of Central Intelligence 1991, p. 1
[177]Albright, Berkhout and Walker 1997, p. 327
[178]Richelson 2006, p. 355
[179]Sciolino 1991
[180]Sciolino 1991
[181]Richelson 2006, pp. 447-502

process. First, the determination that Iraq was reconstituting its nuclear weapons program was based on evidence that was surreally mishandled. The primary piece of evidence, 2000 aluminum tubes bound for Iraq that were seized by CIA agents, should never have been identified as intended for a nuclear use. Contrary to CIA and, subsequently, DIA and NGIC assertions, the tubes were not well-suited for use in a centrifuge[182] and identical tubes had been purchased earlier for a rocket program.[183] Instead, a single CIA analyst misled the entire intelligence establishment with doctored tests and misstatements; correct dissenting opinions from INR and Energy were deemphasized in the unusually rushed 2002 National Intelligence Estimate. Other evidence was based on dual-use technologies and secondary information regarding movements of former weapons personnel. A Senatorial report following the invasion found that no earlier estimate had detected a renewed weapons effort; the 2002 NIE asserted that a program had been operative since the departure of U.N. inspectors in 1998.[184] This same committee found with INR that the evidence did not add up to a compelling case for reconstitution.[185] In fact, Iraq had kept nuclear personnel trained and working on related technologies but there was no recent increase in activity indicative of serious reconstitution.[186]

These difficulties add up to a number of conclusions. First, and most controversially, the sudden revision of estimates, selective transmission of intelligence to the President, and direct attention of Vice President Cheney suggests that executive ideology played at least an indirect role in distorting the analytic process. Conversely, the Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction found no indication that community distorted the evidence and blamed "poor analytical tradecraft"; however, it is likely ideology played some role[187] (H1). Second, very poor Iraqi-US relations almost certainly served to create a sense of mistrust and push estimates forward (H2a,b). Third, analysts underestimated the breadth of Hussein's intentions for his program (H5). Fourth, it is likely that de-emphasized but persistent discussions of nonexistent Nigerian uranium deals contributed to push estimates forward (H6). Fifth, the second Iraq process is the only instance in which multiple advocacy between agencies clearly biased the final estimate: INR and Energy arguments almost certainly did not receive the attention they deserved (H7). Sixth, data from the CIA's tubes tests was not circulated fully, nor was the DCI aware of INR opinions to transmit to the President[188] (H8). Signals versus noise was also a serious problem regarding Iraq: even though data was very scarce, analysts seemed particularly eager to chase noise regarding former program personnel (H9). Eighth, past experience and administration rhetoric with the Iraqi nuclear weapons program almost certainly created a mindset in which analysts searched for every indication of a program to avoid "getting beat"(H11). Lastly, and perhaps most critically, experience derived from past experience with Iraq was clearly not relevant to the 2002 estimate (H12).

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[182]Senate Committee on Intelligence 2004, p. 136
[183]Albright 2003
[184]Senate Committee on Intelligence 2004, p. 85
[185]Senate Committee on Intelligence 2004, p. 129
[186]Senate Committee on Intelligence 2004, p. 141
[187]Silberman and Robb 2005, p. 557
[188]Senate Committee on Intelligence 2004, p. 139

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