***No Modernization on their Radar: The Long Road to DEW Line* *Replacement***

**Alexander Michael Daniel**

**Introduction**

Initially proposed in the early 1950s in response to the threat of the Soviet bomber, the Distant Early Warning (DEW) Line of radars was operational by 1957, ultimately spanning as far west as the Aleutian Islands and as far east as Iceland. Despite being considered an engineering marvel at the time, plans to replace it were drawn up less than a decade later. DEW Line modernization[[1]](#footnote-1) would not, however, be completed until the early 1990s, more than a decade after government studies had identified the DEW Line as wholly inadequate for defence against the modern Soviet threat, and indeed, more than a year after the Soviet Union itself was dissolved. This paper will demonstrate how strategic-political alliance factors contributed to delays in DEW Line modernization. Indeed, this was the reality despite a clear understanding by the military of both the poor condition of the DEW Line and the persistence of the threat it was deployed to deter.

The paper begins with a brief history of attempts to modernize the DEW Line, beginning with a (failed) 1967 plan approved by United States (US) Secretary of Defense Robert S. McNamara, and ending with the 1985 North American Air Defense Modernization (NAADM) agreement that ultimately saw the DEW Line replaced by the North Warning System (NWS). This history culminates in a DEW Line that contemporary writing described as “geriatric” and *porous* to Soviet bombers and cruise missiles.[[2]](#footnote-2) Such a description demands an explanation: how, amid the Cold War, could the primary line of warning against Soviet incursion in the north be allowed to get to such a state?

 This history is followed by a discussion of how strategic-political alliance factors led to delays in the modernization of the DEW Line. First, the defence strategy and priorities of defence leaders in North America changed substantially in the decades between the initial construction of the DEW Line and the official decision to replace it. Most significantly, the perceived threat of intercontinental ballistic missiles (ICBMs) drew attention away from the problem of continental air defence, even, at times, causing leaders (like McNamara) to believe the kind of continental air defence enabled by the DEW Line was not worthwhile at all. Second, changes in leadership, and the relationship between Canadian and American leadership, both explain further delays: while the 1979 “Joint US-Canadian Air Defense Study” (JUSCADS) clearly identified the dilapidated state of North American air defences (including the DEW Line) to both governments, the NAADM would take another six years to be signed. The final section of the paper briefly discusses two other possible factors for the delay, namely construction time and technology; it will not be claimed that the strategic-political alliance factors discussed above are the only ones relevant to understanding the delay in DEW Line modernization. The paper finishes with a discussion of the aforementioned factors in light of the current period of North American Aerospace Defence Command (NORAD) modernization and concludes that they are broadly vindicated.

**A Brief History of (Attempts at) DEW Line Modernization: 1967-1979**

The DEW Line was a “remarkable engineering project”; its construction in two years was the result of “[e]xtraordinary efforts” culminating in “an achievement of epic proportions.”[[3]](#footnote-3) Initially conceived at the 1952 “Summer Study Group” at the Massachusetts Institute of Technology (MIT), construction began in 1955, with all 57 stations operational by the end of 1957.[[4]](#footnote-4) The years 1958 and 1959 saw further plans to upgrade the Line, including extensions into the Aleutian Islands in the west and Greenland in the east. With that complete by 1961, the DEW Line was “an undoubted success for the designers of the air defence system.”[[5]](#footnote-5)

It may come as some surprise, then, that plans for its replacement would be drawn up within a decade. In November 1967, Robert McNamara, Secretary of Defense under both John F. Kennedy and Lyndon B. Johnson, approved a plan to modernize the air defences of the continent by the mid-1970s.[[6]](#footnote-6) For early warning, this was to consist of the use of Over-the-Horizon backscatter radar (OTH-B) and Airborne Warning and Control Systems (AWACS) to monitor for incursions from the north, and importantly, would involve the phasing-out of the DEW Line (contingent on the continued successful development of both the OTH-B and AWACS technologies). Advice about the plan from the Departments of National Defence and External Affairs to Lester B. Pearson’s cabinet was also positive, although Defence Research Board (DRB) scientist George Lindsey, himself a member of the Summer Study Group, is recorded as providing a cautionary outlook concerning the prospects for north-facing OTH-B and the issue of how (or if) Canada would pay for and/or base the AWACS aircraft.[[7]](#footnote-7)

Though a detailed discussion of the deeper reasons for McNamara’s desire to replace the DEW Line is deferred to later in the paper, the OTH-B and AWACS presented a cheaper alternative to the DEW Line at a time of cuts to defence spending, with the added potential for improved detection performance.[[8]](#footnote-8) In particular, there were concerns about low-flying targets, an issue for ground-based radar in general. A back-of-the-envelope calculation[[9]](#footnote-9) shows that while the line-of-sight detection distance of an object at 30,000 feet for radar with a nominal 100-foot height is roughly 225 miles (362 kilometres), the same radar can detect an object at 500 feet for only 40 miles (64 kilometres); given that the intermediate stations of the DEW Line were spaced at approximately 50-mile intervals, the concern that low-flying bombers might sneak in between two stations was not unfounded. The OTH-B and AWACS would both be unaffected by this issue, as both *looked down* on targets: the OTH-B by reflecting waves off the ionosphere, and AWACS by physically placing the radar transmitter on a high-flying aircraft. Though it was expected at that time that OTH-B might not work when searching directly north due to auroral activity in the ionosphere,[[10]](#footnote-10) it was thought that three AWACS in continuous operation would be sufficient to provide coverage.[[11]](#footnote-11)

Obviously, this phasing-out of the DEW Line did not occur as planned, though the modernization plan that called for it would survive McNamara’s departure as Secretary of Defense in 1968. The Continental Air Defense (CONAD) Command History of 1970 reveals that the DEW Line was still slated to be replaced by AWACS and OTH-B whenever those systems “became operational.”[[12]](#footnote-12) The 1972 CONAD Command history re-emphasizes the value of both AWACS and OTH-B to the modernized air defence concept, though no explicit mention is made of the DEW Line being phased out.[[13]](#footnote-13) In 1972, the administration of Richard Nixon promised to continue the modernization effort but did not clarify what the “nature” of that modernization would be.[[14]](#footnote-14) Meanwhile, at a contemporary House Armed Services subcommittee dedicated to studying the state of American air defence, the Commander-in-Chief of NORAD, General Seth J. McKee, described the air defences as a “shell” of their former selves and attempted to convince the committee of the continued existence of the Soviet bomber threat.[[15]](#footnote-15)

The Department’s 1972 five-year plan for air defence included continued research and development on both the AWACS and OTH-B. An August 1973 air defence study by the Aerospace Defence Command (ADC) echoed McKee’s belief that air defences were both necessary and neglected, noting that since 1967, defences had been slowly phased down, while the modernized defences touted to replace them had been delayed, leading to a degraded state of defence. But the twist of fate that would end the prospect of AWACS replacing the DEW Line came from a decision in the same month from Nixon’s newest Secretary of Defense, James R. Schlesinger: AWACS would be transferred to Tactical Air Command (TAC), serving in a continental defence role only as “augmentation” when needed.[[16]](#footnote-16)

The OTH-B survived this change of priority, but issues with detecting targets while looking directly north persisted. A two-year test starting in December of 1972 with an OTH receiver in Cambridge Bay resulted in the “original optimism” for the technology “diminish[ing] substantially.”[[17]](#footnote-17) Schlesinger duly approved an extension for the DEW Line to 1980 (which had previously been slated for deactivation in 1976), with the idea that DEW Line gaps would be filled by newer ground-based radars if north-facing OTH-B could not be made to work. Such a plan was clearly needed: a 1975 estimate suggested that there were about 200 gaps in the DEW Line below 1000 feet, and by early 1976, a Maine OTH-B prototype was already a year behind its desired 1977 completion date. Expectations for the success of the OTH-B program were so low that it was nearly cancelled in 1977 by President Jimmy Carter’s Secretary of Defense, Harold Brown, the man who wrote the very 1967 modernization plan that called for the OTH-B in the first place.[[18]](#footnote-18)

With the AWACS unavailable, and the OTH-B program struggling, it is no surprise that air defence planners began looking, for the first time, to develop a DEW Line modernization plan that did not rely on either of the two ill-suited technologies. The 1976 Project *Seek Frost* would deploy “13 minimally-manned long-range radars and 57 short-range unattended radars to provide altitude coverage from 100 to 100,000 feet.”[[19]](#footnote-19) Brown approved the plan in the fall of 1977, with expectations for initial functionality by 1984 and project completion by 1987. In May 1978, Canadian Minister of National Defence Barney Danson wrote to Brown, recommending a joint US-Canadian study of the air defence modernization problem for the whole continent, rather than two independent efforts by each country. This ultimately led to the 1978-1979 Joint US-Canadian Air Defense Study (JUSCADS), tasked with studying North America’s air defence needs through to the year 2000 (and with all haste).[[20]](#footnote-20)

**Saying “Adieu” to the DEW Line: 1979-1985**

The JUSCADS study detailed explicitly both the need for and the possibility of, early warning against the contemporary Soviet threat. The DEW Line was in a dire state, and the Soviet threat now included air-launched cruise missiles (ALCMs) in addition to the traditional bomber threat. The report provided a variety of options for a modernized air defence plan, each examined for its expected cost and effectiveness. Convened early in 1979, the group was initially focused heavily on space-based options but was sent back to the drawing board in the spring by feedback from leadership, like the Canadian Vice-Commander of NORAD, who noted that a focus on space systems would not be adequate for air defence in the 80s and 90s when those systems would not yet be mature. This set back the delivery of the report by a few months, but the resulting effort ultimately received the praise of NORAD Commander General James Hill. Of the modernization options outlined in the report, NORAD preferred the option titled “1B” with option *2* second best; both would see the DEW Line replaced with more modern and capable ground-based radars. Above all else, the JUSCADS study had given NORAD a concrete mission and responsibility with respect to air defence, something that had been left somewhat ambiguous over the previous few decades.[[21]](#footnote-21)

The JUSCADS became a “key source[] for development of a comprehensive integrated bi-national air defence master plan [(ADMP)],”[[22]](#footnote-22) subsequently developed by the US Air Staff and submitted for approval by early 1981; subsequently, a March meeting in that year between the American Secretary of Defense and Canadian Minister of National Defence resulted in a public pledge to make *progress* on air defence modernization.[[23]](#footnote-23) However, an official binational agreement to modernize continental air defences (including the DEW Line) would have to wait for another four years. It is difficult to find any evidence that suggests that there was concern about the acceptability of the JUSCADS/air defence master plan in these intervening years. Publicly-available command histories of Aerospace Defense Command (ADCOM) in the intervening years, though heavily redacted, give no reason to suggest either side had cold feet. The 1983 history, for instance, reports that both the Canadian Assistant Deputy Minister for Policy, John Anderson, and Minister for National Defense, John Jacques Blais, made public statements about the necessity and urgency of modernization at a November 1983 conference with a binational audience. Indeed, discussions about cost sharing for modernization had begun at least in 1982.[[24]](#footnote-24) 1983 was also the year that Ronald Reagan, in a public speech, would call upon the scientists of America to deliver him a leak-proof defence against nuclear weapons. This led to his Strategic Defense Initiative (SDI), called *Star Wars* colloquially (and pejoratively), which was a research program to leverage and further develop the latest space and satellite technology in service of missile defence. Clearly, there was an appetite for modernization among politicians on both sides of the border, as there had been in their respective militaries for years.

All the same, DEW Line modernization would not be made official until the signing of the North American Air Defense Modernization (NAADM) agreement so-called *Shamrock Summit* in March of 1985. Signed by Reagan and Brian Mulroney, the agreement was (among other things) the death warrant for the DEW Line, which was slated to be replaced by a North Warning System radar chain that would duly be able to detect low-flying bombers and cruise missiles in a way the DEW Line simply could not. Although the US would cover 88 percent of construction costs, they would pay only 60 percent of continued operating costs, and Canada would be responsible for the operation itself. This is unlike the DEW Line, which was built, paid for, and operated entirely by Americans; thus the NWS would complete the “Canadianization of peacetime air defence in Canada.”[[25]](#footnote-25)

The DEW Line was officially closed at a 15 July 1993, ceremony at Tuktoyaktuk, Northwest Territories,[[26]](#footnote-26) some 36 years after it first officially began operation. To borrow from Twain, for at least 26 of those years, reports of its impending modernization had been greatly exaggerated.[[27]](#footnote-27)

**Strategic-Political Alliance Factors Delaying DEW Line Modernization, Part I: Air Defence as a Political Priority, 1957-1979**

The history discussed in the previous section raises significant questions: if DEW Line modernization had first been planned in the late '60s, why did it take until the early '90s to complete? How could the only source of early warning against Soviet bomber attacks in the Canadian north be allowed to get to such a dilapidated state? Given that the JUSCADS had identified the DEW Line’s limitation to handle the Soviet threat clearly in 1979, why did it take until 1985 to secure a modernization agreement? While this paper will not answer these questions definitively, the next two sections will show how strategic-political alliance factors certainly led to delays in modernization.

The first strategic-political alliance factor resulting in delays to DEW Line modernization is the result of a fact well-known to historians of the period: almost as soon as the DEW Line was finished, missile defence usurped air defence as a priority for politicians thinking about continental defence. Moreover, as the debate surrounding missile defence evolved, it was determined that missile defence was not feasible or worthwhile, and consequently, that air defence was not worthwhile. A vivid example is Schlesinger, testifying to the US Senate in 1974, saying that without adequate missile defences, “a defence against Soviet bombers is of little practical value.”[[28]](#footnote-28) This attitude quite obviously precluded political pressure for air defence modernization, and made it difficult for military leaders who understood the necessity of air defence modernization to convince politicians to spend money on it.

The Soviets launched their Sputnik satellite in October of 1957, mere weeks after NORAD was first stood up. Although US defence officials had been anticipating the Soviet development of ICBMs for several years, Sputnik made clear the reality of the threat; as one author put it: “[t]he booster that could put a satellite in orbit could deliver a thermonuclear weapon to a North American target.”[[29]](#footnote-29) Missile defence thus became a preoccupation of defence planners just as air defence had been for the previous decade.

Whereas (thanks to the DEW Line), there would be hours of warning of a Soviet bomber attack, the new ICBM threat meant that a nuclear payload could reach North America in only thirty minutes. Commensurate with this threat, scientific advisors to US President Dwight D. Eisenhower advocated “the highest possible level of research and development for missile defence,” despite initial assessments indicating that conventional defences might do little to stop a “determined” attack.[[30]](#footnote-30) Subsequent missile defence programs in the US military quickly gained opponents among the President’s scientific advisors. This included the physicist Herbert York, a member of the President’s Science Advisory Council (PSAC), who emphasized the limitations of the missile defence’s electronic systems, and Jerome Wiesner, an MIT professor of electrical engineering, who feared “that the Army was rushing to deploy a defensive system that would be obsolete by the time it was completed.”[[31]](#footnote-31) They instead favoured an approach that combined bans (or at least limitations) on ICBMs paired with limited missile defence “to counter a few extra missiles that the Soviets secretly hid away” (though York remained an opponent even of limited missile defence).[[32]](#footnote-32)

The 1960 presidential election resulted in a victory for John F. Kennedy, who had campaigned in part on the idea that Eisenhower had “allocated too little for defence in the face of a determined Soviet threat.”[[33]](#footnote-33) With him came McNamara as Secretary of Defense; the two rejected Eisenhower’s doctrine of “massive retaliation” to a nuclear strike and desired less escalatory options as a response.[[34]](#footnote-34) McNamara relied heavily on both the scientific advisors (including Wiesner and Harold Brown, then director of Lawrence Livermore Labs and future Secretary of Defense) and his group of systems analysts contained in a new Office of Systems Analysis, led by former RAND economist Alain Enthoven. The new administration would nevertheless receive the same bad news as Eisenhower regarding missile defence: an April 1961 assessment of the American missile defence program led Brown to describe the prospects of preventing a Soviet mass attack against the urban population of the US as *bleak*, despite the billions that had already been invested.[[35]](#footnote-35)

Given that there were serious doubts about the efficacy of missile defence systems, it is unsurprising that there were also questions about whether missile defence should be deployed at all. By the mid-1960s, “York, …Wiesner, and other well-placed physicists began to advance a strange argument,” namely that “the world would be safer without missile defenses.”[[36]](#footnote-36) “The” argument can actually take multiple forms. At its most basic, the idea is that if one side in the Cold War were to develop an impenetrable missile defence shield, it would nullify the nuclear deterrent of the other side. The nullified side would then have no defence against a nuclear strike, and thus have an incentive to strike the first side before the missile defence system could be completed. Building a missile defence system was thus seen as a strategic destabiliser.[[37]](#footnote-37) York and Wiesner preferred a second argument, which emphasized the asymmetry between strategic offences and defences. Whereas the belligerent launching the missile(s) has as much time as they like to plan their attack (including selecting targets, counter-countermeasures, etc.), and can select the time of the attack at their pleasure, the defender must be prepared at all times for an attack and has only minutes to decipher and defeat the opponent’s particular attack when it does occur. McNamara’s systems analysts preferred the argument in their own language: money. The cost of a strategic offence would always be less than the cost of the defence required to defeat it; one specific estimate had $40 billion in missile defences countered by (a mere) $10 billion in the offence.[[38]](#footnote-38) One could then simply spend one’s way to victory over a defensive-minded adversary.[[39]](#footnote-39)

North of the border, the idea that missile defence could contribute to strategic destabilization was noticed at least as early as 1960, in a report by the Joint Ballistic Missile Defence Staff (JBMDS), a group stood-up in 1959 by the Chiefs of Staff to examine ballistic missiles, and ultimately, other strategic issues. R. J. Sutherland, a DRB scientist, member of the JBMDS, and “the most innovative strategic theorist in the country” at the time, would elaborate on this idea in an (estimated) 1962 paper.[[40]](#footnote-40) George Lindsey was also involved in this discussion; a 1959 DRB study of his noted the requirement that both the US and Soviets remain “*vulnerable*” to nuclear attack for the sake of continued stability, a consideration that obviously precludes a robust defence against ICBMs.[[41]](#footnote-41) The (unstated) attitude of the Canadian government towards missile defence at the time was a “preference” that missile defence just “go away.”[[42]](#footnote-42)

McNamara was “impressed”[[43]](#footnote-43) by the arguments against missile defence, and this resulted in a serious blow to the prospects of improved air defences: given that it was not worthwhile to deploy missile defences, “he reasoned that Soviet missiles could eliminate air defence systems in a first strike, rendering them useless should subsequent bomber waves appear in North American skies.”[[44]](#footnote-44) Brown’s proposed modernization plan in 1967 was to reduce personnel by 70 percent and reduce costs by two-thirds, and so should have been embraced by a Secretary under the budget pressure McNamara faced. Instead, “disagreeing philosophically with the need for air defence, McNamara embraced those portions of the Brown Plan that called for reductions and savings, while eliminating, reducing, or delaying new technologies and acquisitions.”[[45]](#footnote-45)

By the mid-1970s, these arguments against missile defence were considered “conventional wisdom.”[[46]](#footnote-46) Schlesinger’s views on the matter are clearly stated in the quote at the beginning of this section. Indeed, it was this reasoning that led to the 1972 Anti-Ballistic Missile (ABM) Defense treaty between the US and the Soviets, limiting each country to only two missile defence sites, i.e., so that nation-wide defence was not possible.[[47]](#footnote-47) The Gerald Ford administration that followed Nixon did not have air defence modernization as a high priority, and for Carter following him, it “was even less of a priority than it had been for the Ford Administration.”[[48]](#footnote-48)

 Thus for Lt. Col. Owen E. Jensen, writing in his history of American air defence from 1960 to 1980, these are the “Years of Decline” in continental air defences.[[49]](#footnote-49) It is clear why there was little hope for DEW Line modernization in this period: it was part of an air defence strategy that politicians at the time thought unworthy of significant funding.

**Strategic-Political Alliance Factors Delaying DEW Line Modernization Part II: Canada-US Leadership and their Relationships, 1979-1985.**

 Two significant reasons can be advanced for the end of the “Years of Decline” in air defences. First was the aforementioned JUSCADS report, which highlighted both the abysmal state of North American air defences and the air-breathing threats with which the Soviets could still endanger the continent. The second is the election of Ronald Reagan, who either was unaware of or did not accept, the arguments against missile defence: while visiting NORAD as a private citizen in 1979, Reagan balked at the idea that there “is nothing we can do” to stop a missile attack.[[50]](#footnote-50) However, the JUSCADS report was delivered to the two governments in 1979, and Reagan took office in January 1981. Why did the NAADM agreement to modernize the DEW Line have to wait until 1985? This section considers two factors leading to delays in that period: changes in leadership on both sides of the border, and the relationships between those leaders.

 The JUSCADS had been initiated after a 1978 suggestion by the Canadian Minister of Defence, Barnett Danson, to Harold Brown, then Carter’s Secretary of Defense. John Anderson, the Assistant Deputy Minister for Policy within the Department of National Defence (DND) at that time, later wrote in 1989 that the success of the study was not just in highlighting the deficiencies of the air defence system at the time and recommending improvements, but also in providing a single “point of reference” for subsequent policy development on both sides of the border, in bringing “Canadian interests to the forefront of… modernization plans,” and the fact that it gave the governments a “fundamental choice” to either invest immediately in air defence modernization or risk the capability failing altogether.[[51]](#footnote-51)

This report was delivered to both countries in the fall of 1979. At this point, Danson was no longer Minister of Defence – the Trudeau government had been defeated in the May 1979 election by Joe Clark’s Conservatives. But before Clark and his government could have a chance to do anything with the JUSCADS results, he was, in turn, defeated by Trudeau in an unexpected February 1980 election. The NORAD Agreement was due for renewal within a few months, and “proclaiming that it wanted to give a House of Commons committee the opportunity to study renewal,” the Trudeau government elected to renew the agreement for only a single year.[[52]](#footnote-52)

 South of the border, Carter had signed Presidential Directive 59 (PD-59) in 1980, which “required the US to develop the capability to fight a *prolonged* nuclear war – one lasting months, not just hours or days” [emphasis original].[[53]](#footnote-53) This requirement placed demands on the sensing architecture used for continental defence, including the DEW Line; PD-59 recognized that the DEW Line provided the early warning that was an important component of their endurance strategy, but also that it was an easy target for initial attack in a war. The upshot of this is that it shows the Carter administration was (or rather, eventually became) aware of the limitations of the contributions of the DEW Line to their strategy and had their own motivation for it to be modernized (or replaced altogether by other capabilities). Alas, Carter would lose re-election to Reagan within 4 months of signing PD-59. What is the significance of all this leadership churn? As Anderson writes:

It is normal for a new government, when it takes office, to spend some time reviewing priorities, programs, and budgets left by its predecessor. In the United States, where new appointments go deeper into the governmental apparatus than in Canada, the period of hiatus in ongoing work following the installation of a new President is often quite long.[[54]](#footnote-54)

It is unsurprising, then, that there were delays in responding to the JUSCADS program despite its recommendation for action “fairly soon.”[[55]](#footnote-55) Nevertheless, Reagan’s interest in defence brought him to Ottawa in March 1981, with one result being the aforementioned mutual pledge to make progress on air defence modernization. Despite a pledge that progress would be made “as quickly as possible,” progress thereafter was “very slow.”[[56]](#footnote-56) Anderson blames, among other things, a 1983 change of defence ministers, Trudeau’s resignation in 1984, and the loss of the September 1984 election by John Turner to Brian Mulroney.[[57]](#footnote-57)

 It was a turbulent period for leadership on both sides of the border. But this alone cannot explain the delays, and new governments do not preclude wholesale the possibility of big decisions on defence: Diefenbaker agreed to the standing-up of NORAD within months of his election in 1957, and Mulroney would agree to the NAADM only a half year after his September 1984 election victory. What else could explain the delay in seeing a modernization agreement through? For the remainder of this section, we will explore how the relationships between the Canadian and US leaders may have played a role.

 Consider what is at stake for a Canadian Prime Minister in negotiating a NORAD modernization agreement. Martin Shadwick, writing in a review of 1985 Canadian politics, provides a convenient summary of the Canadian debate surrounding modernization in that year: “In addition to the central concern that NORAD modernization might in some way link Canada with SDI, the critics seized on the issues of Arctic sovereignty, financing, benefits for Canadian industry, and alleged government secrecy.”[[58]](#footnote-58) Financial costs have been a common concern for Canadians (both citizens and government) throughout the history of NORAD – it is not a coincidence that the Americans bore the whole cost of building the DEW Line. Canadians are also “ultrasensitive about perceived US incursions on sovereignty,” and concerns about sovereignty, especially in the Arctic, have been prompted by NORAD throughout its history.[[59]](#footnote-59) Most significantly, Canadians were worried that NORAD modernization would inevitably involve them in Reagan’s SDI, which was unpopular in Canada.[[60]](#footnote-60) This is a particular instance of a species of (Canadian) problem that has recurred throughout NORAD’s history: NORAD might get Canada sucked into some American activity they would otherwise wish to avoid. The major example prior to SDI was Canada’s insistence on an “ABM clause” in the 1968 renewal – eager to ensure they would not get involved in American anti-ballistic missile defence programs, Canadian negotiators included a clause that explicitly acknowledged that Canadian participation in NORAD was not also an obligation to participate in anti-ballistic missile defence.[[61]](#footnote-61) Above all else, there is the general partisan sniping to endure.[[62]](#footnote-62) And this is just taking Canadian interests into consideration. The Prime Minister must also be concerned with maintaining positive relations with the Americans, something that is “generally at or near the top of the public policy agenda in Canada.”[[63]](#footnote-63) Writing in 1985, John Hamre, a Professional Staff Member of the US Senate Committee on Armed Services, noted that Canada had received criticism in Congress over a lack of financial investment in national defence[[64]](#footnote-64) – unsurprisingly, the Americans did not like the thought that they are giving out a free ride on continental defence.

 The suggestion of this paper is that balancing these concerns is much easier for a Prime Minister when their counterpart south of the border is someone they have a strong personal relationship with and know to be trustworthy. Precisely such a relationship existed between Reagan and Mulroney both during and after their respective tenures in their country’s highest offices. Bonding over their common Irish heritage and outlook on the world, Reagan was “prepared, indeed, anxious to do business with Mulroney,”[[65]](#footnote-65) while Mulroney in turn had used his 1984 Speech from the Throne to make clear that “the re-establishment of a *specia’* relationship with the United States [was] a major foreign policy priority.”[[66]](#footnote-66) When asked in a 2021 interview about the role his friendship with Reagan played in both “facilitating bilateral cooperation and managing policy disagreements,” Mulroney said “It was indispensable… Reagan felt great loyalty to Canada and loyalty and friendship to me.”[[67]](#footnote-67) This context helps make sense of the fact that Mulroney could leave the 17-18 March 1985 *Shamrock Summit* with both a deal to pay only 12 percent of NWS construction costs and 40 percent of subsequent operating costs, and a relationship with the American President so strong that they ended the Summit by singing a rendition of *When Irish Eyes are Smiling* together.

 In contrast, Trudeau and Reagan had a far more chequered personal relationship. It was not entirely negative: Reagan would describe himself as having “liked” Trudeau upon first meeting him, and Trudeau would describe him as “pleasant and congenial.”[[68]](#footnote-68) But this was nothing more than two leaders doing their best to maintain an important bilateral relationship. In his autobiography, Reagan was critical of Trudeau, and would record in his diaries that he would sometimes find him “rude, obnoxious, and arrogant.”[[69]](#footnote-69) Trudeau may have done something to earn that description, describing Reagan as “not a man for thoughtful policy”; the two “were about as far apart in outlook and personality as two people could be.”[[70]](#footnote-70) The two certainly did not “have each other’s backs.” Trudeau was also perceived by some as being far more neutral on the US-Soviet conflict than a President would have hoped for from the leader of their neighbour and ally.[[71]](#footnote-71) This relationship did not altogether preclude collaboration on defence, of course, as the two signed both the 1981 NORAD renewal together and a 1983 agreement to allow American cruise missile testing on Canadian soil.[[72]](#footnote-72) The latter was controversial and required Trudeau to expend significant political capital, which in turn could have contributed to a souring on subsequent defence cooperation with the Americans.[[73]](#footnote-73)

 Churn in leadership on both sides of the border clearly led to delays in modernization, and it is plausible that the relationships between Reagan and his concurrent Prime Ministers helped explain the timing of DEW Line modernization. One is left with the impression that, had Trudeau and Carter, “a good American friend,”[[74]](#footnote-74) both won their respective 1979 and 1980 re-election bids, DEW Line modernization might have actually been finished before the Cold War was.

**Other Factors, and North Warning System Modernization**

It is not claimed here that the previous section exhausts all factors relevant to understanding the timing of DEW Line modernization. At least two other factors must be taken into consideration, though limitations of space preclude a detailed analysis of them here. The first factor is construction time. The DEW Line was finished in only two years (and within five years of the idea first emerging from the Summer Study Group). In contrast, the idea of the North Warning System goes back to at least the 1981 Air Defence Master Plan, and was approved in the 1985 NAADM, but did not officially take over from the DEW Line until 1993. A detailed analysis would be required to explain the comparative length of the latter process.

The second factor is, broadly speaking, technology. We have seen that OTH-B was a crucial part of the 1967 modernization plan and that the subsequent failure of engineers to get it to work when looking north led to delays. Likewise, the JUSCADS report had been delayed for relying too heavily on immature satellite technology. It is not completely correct, however, to suggest that technology was a factor in delaying DEW Line modernization. Certainly, if OTH-B had been made to work facing north, it is likely that the DEW Line would have been replaced much earlier than 1993. On the other hand, the failure of OTH-B did not mean that earlier DEW Line modernization was impossible. The 1976 “Seek Frost” modernization plan used ground-based radars, as does the NWS. Two significant improvements of the NWS over the DEW Line are its increased automation and the electronically, rather than mechanically, scanned antennas. Every DEW Line radar required at least 4-5 people staffing it, and the largest ones had dozens.[[75]](#footnote-75) The NWS radar line plan had 13 main stations with *minimal attendance* and 39 smaller stations with no personnel at all.[[76]](#footnote-76) While the degree of automation available in the 1980s would undoubtedly exceed the degree available in the 1970s, the 1970s automation would have markedly improved upon the 1950s automation and would have allowed for reductions in personnel costs. Moreover, an electronically scanned array of radars had been in development at ARPA/DARPA since the late 1950s and had been successfully deployed in the field in the early 1960s.[[77]](#footnote-77) There thus does not seem to be a strong case for the idea that technology limitations would have prevented earlier DEW Line modernization according to something like the 1976 plan (had there been a sufficient political desire to make it happen).

How are the factors discussed in this paper relevant to the modernization of the NWS? Russian long-range bomber patrols of the Arctic resumed in 2007 and have continued since, which has included entries into the Canadian and American Air Defence Identification Zones (an area monitored but not controlled by NORAD) and NORAD interceptions of the bombers.[[78]](#footnote-78) The need for adequate air defence in the North has thus been clear for some time, and both the 2022 and 2014 instigations by Russia of war in Ukraine have only increased understanding that Russian threats are not idle.[[79]](#footnote-79) As for leadership and their relationships, while President Joe Biden agreed to the more recent NORAD modernization plan in his first year in office, his previous experience of eight years in the executive branch included heavy involvement in the American response to Russia’s 2014 invasion of Crimea: “Obama essentially outsourced the portfolio to [Biden].”[[80]](#footnote-80) Prime Minister Justin Trudeau had himself been in the position for six years. And while there is no particular evidence that Trudeau and Biden have a relationship on par with that of Reagan and Mulroney, after four years of Trump, dealing with Biden must come as a relief to Trudeau.[[81]](#footnote-81) Thus the main strategic-political alliance factors discussed above are broadly vindicated. One difference between the two modernization initiatives is the role of technology. While it was argued briefly above that technology cannot be used as an excuse for DEW Line modernization, the role of technology in NWS modernization cannot be so overlooked. In particular, a modern OTH system has finally been made to work facing north and is the cornerstone of current modernization plans.[[82]](#footnote-82) A future analysis of NWS modernization timing would need to consider the timing of progress on OTH research.

Has NWS modernization itself been *delayed*? This question must be left to future historians and political scientists for a complete response, but there are already strong indications available now that it will ultimately be answered affirmatively. In their recent study of NORAD, Andrea Charron and James Fergusson provide evidence to this end (though it is hardly the primary focus of the book).[[83]](#footnote-83) They describe the NWS as “already obsolete relative to the capabilities of competitors, its location, and the threat environment.”[[84]](#footnote-84) In support of this, they cite the existence of modern cruise missiles capable of being launched by Russia (and potentially China) from outside the coverage of the NWS with enough range to hold important targets in North America at risk, and the inability of the NWS to detect these missile once they do arrive within the nominal coverage regions of the NWS.[[85]](#footnote-85) Moreover, a binational government report from 2006 assessed the NWS as being obsolete by 2025, a year also identified by the current Trudeau government as one beyond which the NWS may no longer be operational.[[86]](#footnote-86) Indeed, in the Trudeau government’s 2017 defence white paper, *Strong, Secure, Engaged* (SSE), “renewal” of the NWS was listed as a new priority for the government, but little detail was provided as to what that would entail.[[87]](#footnote-87) This led academics writing shortly after the release of SSE to call NORAD Modernization its “missing chapter.”[[88]](#footnote-88)

**Conclusion**

 Finished in 1957, the DEW Line was a feat of engineering in its time. Nevertheless, plans for its modernization began within ten years but were not realized for nearly thirty thereafter. Although military planners were never unaware of either the poor condition of the DEW Line or the continued threat to the north it was required to deter, modernization was delayed by a lack of political interest in air defence, leadership churn in the late ‘70s and early ‘80s, and political relationships between Canadian and American leaders.

 What is the significance of this for understanding the current period of NORAD Modernization? It is worth quoting Charron and Fergusson at length:

[T]he requisite technologies relative to the various domain sensors and system integrations are likely to emerge at varying points in time, such that the system’s construction will require an incremental approach rather than waiting for the ‘perfect’ system. Nor will the system likely reach some end date. Both the DEW Line and NWS were *one and done* systems, employing existing technology and designed to last for decades. A new system, in contrast, is better understood as *never done*, as it will need to be adaptable as technology continues to advance.[[89]](#footnote-89)

It is hard to find fault with these claims, with one exception. The same reasoning used here for NWS modernization also held true for the DEW Line in its time. Though perhaps occurring at a less rapid pace than it has in recent decades, technology was dramatically changing (and improving) throughout the ‘60s, ‘70s, and ‘80s, and an incremental approach to DEW Line improvement was possible (and a better alternative to allowing it to slowly degrade). That the DEW Line was a *one-and-done* system was not because its designers deliberately chose it to be so. It was a *one-and-done* system because the governments of the time chose not to invest in it, despite the pleas of continental air defence planners.

The history of DEW Line modernization makes clear the difficulties that face those attempting the complicated, large-scale, binational project that NORAD modernization entails. Among other things, interest in continental defence may wane, and only revive at a time when modernization should have begun a decade prior; a supportive politician may lose re-election, or an unsupportive politician may win; politicians on both sides of the border may not see eye-to-eye well enough to negotiate a mutually-agreeable path forward for modernization. Thus, those tasked with modernizing continental air defence must strike while the iron is hot and make the most of the opportunity that has been provided, for subsequent modernization may be decades away.

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1. The spelling of “modernization” follows the Canadian government’s spelling of the term in official statements. For all other words with a suffix like “-ization,” “-ize,” or “-izing,” this paper follows the standard of the *Journal of Military and Strategic Studies* in replacing the “z” with an “s.” [↑](#footnote-ref-1)
2. Martin Shadwick, “NORAD.” in *Canadian Annual Review of Politics and Public Affairs 1985*, ed. R. B. Byers, (Toronto: University of Toronto Press, 1988), pp. 237-238. [↑](#footnote-ref-2)
3. Quotes respectively from David Cox, *Guarding North America:*

*Aerospace Defense During the Cold War 1957-1962* (NORAD History Office, 2007), p. 53; Kenneth Schaffel, *The Emerging Shield: The Air Force and the Evolution of Continental Air Defense, 1945-196* (Office of Air Force History, 1991), p. 216; and Thomas W. Ray, *A History of the DEW Line: 1946-1964* (ADC Historical Study 31 November, 1968), p. 28. [↑](#footnote-ref-3)
4. Detailed discussion of the history leading up to the development of the DEW Line and the formation of NORAD are contained in Schaffel, *The Emerging Shield*, and Joseph Jockel, *No Boundaries Upstairs: Canada, the United States and the Origins of North American Air Defence, 1945-1958* (Vancouver: University of British Columbia Press, 1987). More concise overviews are found in Cox, *Guarding North America*, and Ray, *A History of the DEW Line*. [↑](#footnote-ref-4)
5. Cox, *Guarding North America*, p. 59. [↑](#footnote-ref-5)
6. For further details and discussion on this modernization plan, see Joseph T. Jockel, *Canada in NORAD, 1957-2007: A History* (Montreal & Kingston: McGill-Queen's University Press, 2007) pp. 66-68, and CONAD Command History Division, *CONAD Command History, 1968*. (Joint Staff Headquarters, CONAD, 1969), 1-3 and 59-78.pp. [↑](#footnote-ref-6)
7. Jockel, *Canada in NORAD*, 68. George Lindsey is perhaps the most prominent defence scientist Canada has ever produced. The University of Toronto Press has published a compilation of some of his works, and the Laurier Military History Archive at Wilfred Laurier University is currently in the process of digitising an archive of his work. [↑](#footnote-ref-7)
8. For instance, the Summer Study Group had estimated an annual operating cost for the DEW Line of 100 million US dollars; see Schaffel, *The Emerging Shield*, p, 176. A US Bureau of Labor Statistics inflation calculator gives a dollar in August 1952 the same purchasing power as $11.12 in September 2022 (<https://www.bls.gov/data/inflation_calculator.htm>, accessed 18 October 2022). Thus the *annual* operating costs on this estimate would be over a billion dollars a year in today’s US dollars. [↑](#footnote-ref-8)
9. Assuming a smooth, spherical Earth, some trigonometry gives the formula of the distance from an object of height *h* off the surface of the Earth to the horizon as $d=\sqrt{\left(h+R\right)^{2}-R^{2}}$, where *R* is the radius of the Earth. To get the line-of-sight distance from the radar to, say, a bomber, the formula is used twice: first from the radar to the horizon, then from the horizon to the bomber. Using the heights discussed in the main body of the paper and an Earth radius of 20,903,520 feet yields the numbers discussed above. [↑](#footnote-ref-9)
10. To be discussed below. [↑](#footnote-ref-10)
11. Jockel, *Canada in NORAD*,p. 67. [↑](#footnote-ref-11)
12. CONAD Command History Division, *Continental Air Defense Command, Command History 1970* (Joint Staff Headquarters, CONAD, 1971), p. 33. [↑](#footnote-ref-12)
13. CONAD Command History Division, *Continental Air Defense Command, Command History 1972* (Joint Staff Headquarters, CONAD, 1973), pp. 33-39, and 44. [↑](#footnote-ref-13)
14. David N. Spires, *North American Air/Aerospace Defense, 1972-1983* (NORAD Research Report (Contract #F49642-88-C5157), 1992), p. I-1. Following Spires’ notation, the pages for this book are given by Chapter (in Roman numerals) followed by the page number within that chapter. [↑](#footnote-ref-14)
15. Spires, *North American Air/Aerospace Defensepp. ,* I-2 – I-3. [↑](#footnote-ref-15)
16. Ibid,pp. I-19 - I-21. [↑](#footnote-ref-16)
17. Ibid, pp. II-24. [↑](#footnote-ref-17)
18. See Ibid.,pp. IV-15 and V-6. [↑](#footnote-ref-18)
19. Ibid., p. V-7. [↑](#footnote-ref-19)
20. See Ibid, V-38; Jockel, *Canada in NORAD*, p. 100. [↑](#footnote-ref-20)
21. Spires, *North American Air/Aerospace Defense*, pp. V-38 – V-42; ADCOM History Office, *ADCOM History Extracts 1979 & 1980,* pp. 51-58. [↑](#footnote-ref-21)
22. Spires, *North American Air/Aerospace Defense*, p. V-45. [↑](#footnote-ref-22)
23. Jockel, *Canada in NORAD*, 101 and p. 116. [↑](#footnote-ref-23)
24. ADCOM Command History Office, *History of Space Command ADCOM, January-December 1983*, p. 88. [↑](#footnote-ref-24)
25. Jockel, *Canada in NORAD*,pp. 122. See 119-125 more generally. [↑](#footnote-ref-25)
26. Dennis C. Mills, *History of North American Aerospace Defense Command 1993-1994* (HQ NORAD History Office, 1996), p. 43. [↑](#footnote-ref-26)
27. Though the oft-repeated version “Reports of my death have been greatly exaggerated” is apparently a misquote; see e.g., "Mark Twain," in *Oxford Essential Quotations*, ed. Susan Ratcliffe. (Oxford University Press), https://www.oxfordreference.com/view/10.1093/acref/9780191843730.001.0001/q-oro-ed5-00011053. Accessed 23 October 2022. [↑](#footnote-ref-27)
28. Schaffel, *The Emerging Shield*, 272, citing the 1973-1974 Air Defense Command’s Command History and Owen E. Jensen, “Air Defense of North America, Historical Imperatives for Change,” (Thesis, Naval Postgraduate School, 1982), p, 169. [↑](#footnote-ref-28)
29. B. Bruce-Biggs, *The Shield of Faith* (New York: Simon & Schuster, 1990); the digital edition from which this quote was sourced did not list page numbers, but the quote can be found in the first paragraph of Chapter 4. [↑](#footnote-ref-29)
30. Rebecca Slayton, *Arguments that Count: Physics, Computing, and Missile Defense, 1949-2012* (Cambridge, MA: MIT Press, 2013), p. 42. [↑](#footnote-ref-30)
31. Ibid., 56. [↑](#footnote-ref-31)
32. Ibid., 56. [↑](#footnote-ref-32)
33. Owen E. Jensen, “The Years of Decline: Air Defense from 1960 to 1980,” in *Strategic Air Defense*, ed. Stephen J. Cimbala, (Scholarly Resources Inc., 1989),pp. 24-25. See also James G. Fergusson, *Canada and Ballistic Missile Defence, 1954-2009: Deja Vu All Over Again* (Vancouver: University of British Columbia Press, 2010), 28. [↑](#footnote-ref-33)
34. Slayton, *Arguments that Count*, p. 66. [↑](#footnote-ref-34)
35. Ibid., 80-81, citing an Office of the Director of Defense Research & Engineering (ODDR&E) document “Assessment of Ballistic Missile Defense Program” from 17 April 1961, available in the Digital National Security Archive in the Nuclear History Collection as document 1388. [↑](#footnote-ref-35)
36. Slayton, *Arguments that Count*, p. 85. See also Fergusson, *Canada and Ballistic Missile Defence,* pp. 27-32. [↑](#footnote-ref-36)
37. Does this argument still hold up today? A recent paper argues that, given the range of conventional and tactical nuclear missile options available to belligerents, a more subtle argument for at least some missile defence is possible. See Keith B. Payne, “Deterrence Via Mutual Vulnerability? Why Not Now,” *National Institute for Public Policy, Information Series*, no. 536 (2022). This approach is broadly consonant with the approach taken by current NORAD/USNORTHCOM Commander Gen. Glen VanHerck; see e.g., Glen D. VanHerck, “Deter in Competition, Deescalate in Crisis, and Defeat in Conflict,” *Joint Force Quarterly 101*, 2nd Quarter, (2021): pp. 4-10. [↑](#footnote-ref-37)
38. Fergusson, *Canada and Ballistic Missile Defence*, pp. 31-32. [↑](#footnote-ref-38)
39. Slayton, *Arguments that Count*, pp. 85-90. [↑](#footnote-ref-39)
40. The quote is from Andrew Richter, *Avoiding Armageddon: Canadian Military Strategy and Nuclear Weapons, 1950-1963* (Vancouver: UBC Press, 2002), p. 63; the date of the Sutherland paper is reported in Richter as not being listed, but Richter estimates that the date of publication would have been 1962. See pages pp. 64-67. [↑](#footnote-ref-40)
41. Ibid., p. 68. [↑](#footnote-ref-41)
42. Fergusson, *Canada and Ballistic Missile Defence*,p. 22. [↑](#footnote-ref-42)
43. Slayton, *Arguments that Count*, p. 92. [↑](#footnote-ref-43)
44. Schaffel, *The Emerging Shield*, p. 268. [↑](#footnote-ref-44)
45. Jensen, “The Years of Decline,” p. 34. [↑](#footnote-ref-45)
46. Ibid., p. 40. [↑](#footnote-ref-46)
47. Although the Soviets obviously agreed to the ABM Treaty, it does not mean they were initially as receptive to the anti-defence arguments as McNamara was; see e.g., Slayton, *Arguments that Count*, pp. 90-91, 97, and 106. [↑](#footnote-ref-47)
48. John Anderson, “Canada and the Modernization of North American Air Defense,” in *The U.S.-Canada Security Relationship: The Politics, Strategy, and Technology of Defense,* eds. David G. Haglund and Joel S. Sokolsky, (Taylor and Francis, 1989), p. 370. The page numbers here refer to a digital version published by Routledge in 2019. [↑](#footnote-ref-48)
49. Jensen, “The Years of Decline,” p. 23. [↑](#footnote-ref-49)
50. Jockel, *Canada in NORAD*, p. 109, citing Martin Anderson, *Revolution* (New York: Harcourt Brace Jovanovich, 1988), pp. 80-83. [↑](#footnote-ref-50)
51. Anderson, “Canada and the Modernization of North American Air Defense,” pp. 371-372. [↑](#footnote-ref-51)
52. Jockel, *Canada in NORAD*, p. 109. [↑](#footnote-ref-52)
53. Jeffrey Richelson, “PD-59, NSDD-13 and the Reagan Strategic Modernization Program*,”* Vol. 6:2. *Journal of Strategic Studies* 6, no. 2 (1983): p. 125. See the entire paper for a discussion of PD-59 and the continuities with the subsequent Reagan administration’s strategic thinking. [↑](#footnote-ref-53)
54. Anderson, “Canada and the Modernization of North American Air Defense,” p. 373. [↑](#footnote-ref-54)
55. Ibid., p. 372. [↑](#footnote-ref-55)
56. Ibid., pp. 374 and 383. [↑](#footnote-ref-56)
57. He also suggests Reagan’s preoccupation with his Strategic Defense Initiative (SDI) in 1983 and Trudeau’s preoccupation with his peace initiative as other causes for delay. If so, these fit well with the first factor discussed in this section, namely the lowering of air defence as a political priority. [↑](#footnote-ref-57)
58. Shadwick, “NORAD,” p. 239. [↑](#footnote-ref-58)
59. Ken S. Coates, P. Whitney Lackenbauer, William R. Morrison, and Greg Poelzer, *Arctic Front: Defending Canada in the Far North* (Toronto: Thomas Allen Publishers, 2008), p. 124. See pp. 68-79 for discussion of sovereignty issues during the early NORAD years, and Chapter 4 for the same during the period of the NAADM signing (though the whole book is a worthwhile read). [↑](#footnote-ref-59)
60. See Shadwick, “NORAD,” 236-242, and Joel J. Sokolsky, "Changing Strategies, Technologies and Organisation: The Continuing Debate on NORAD and the Strategic Defense Initiative," *Canadian Journal of Political Science/ Revue canadienne de science politique* 19, no. 4 (1986): pp. 751-774, for discussion of the debate in government and the press over NORAD and SDI. Writing in 1986, it is interesting to note that Sokolsky also refers matter-of-factly to the *decline* in the bomber threat to North America. With greater hindsight, both Schaffel (writing in 1991) and Spires (writing in 1992) note that the bomber threat had never really diminished (even if it was less pressing than the ICBM threat); see Schaffel, *The Emerging Shield*, p. 268, and Spires, *North American Air/Aerospace Defense*, pp. I-29 and IV-1. For discussion of the unpopularity of SDI in Canada, see Ann Denholm-Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD, 1958-96* (New York: St. Martin's Press, 1998), pp. 181-183, and the whole of Chapters 8 and 9 in the same book for a discussion of Canadian public perception NORAD and NORAD-related issues more generally. [↑](#footnote-ref-60)
61. See e.g., Fergusson, *Canada and Ballistic Missile Defence*, pp. 44-49. [↑](#footnote-ref-61)
62. See Sokolsky, “Changing Strategies, Technologies and Organisation,” p. 762, for a vivid example: the (opposition) Turner Liberals blamed the Mulroney Conservatives for the removal of the ABM clause, a choice which was made under Trudeau. [↑](#footnote-ref-62)
63. R. B. Byers, “NORAD, Star Wars, and Strategic Doctrine: The Implications for Canada,” in *Aerospace Defense, Canada’s Future Role?,* eds. R. B. Byers, John Hamre and George R. Lindsey, (Toronto: Canadian Institute of International Affairs, 1985), p. 31. [↑](#footnote-ref-63)
64. John Hamre, 1985. "Continental Air Defence, United States Security Policy, and Canada-United States Defence Relations." in *Aerospace Defense, Canada's Future Role?*, eds. R. B. Byers, John Hamre and George R. Lindsey. (Toronto: Canadian Institute of International Affairs, 1985),pp. 27-28. [↑](#footnote-ref-64)
65. Donald Abelson, **“**Brian Mulroney, Ronald Reagan, and the Politics of Friendship,” *Mulroney Papers in Public Policy and Governance*, No. 8 (2022): p. 1. [↑](#footnote-ref-65)
66. Byers, “NORAD, Star Wars, and Strategic Doctrine,” p. 49. [↑](#footnote-ref-66)
67. Abelson, “The Politics of Friendship,” p; 10. The interview in question had been conducted by Abelson over the phone in 2021. [↑](#footnote-ref-67)
68. Ibid., p. 10, citing *The Reagan Diaries*, ed. Douglas Brinkley (New York: HarperCollins, 2007), a collection of Reagan’s remarks in his daily diary for the Reagan quote, and Trudeau’s memoirs for the Trudeau quote: Pierre Elliot Trudeau, *Memoirs* (Toronto: McClelland & Stewart 1993). [↑](#footnote-ref-68)
69. Abelson, “The Politics of Friendship,” p. 2, again citing Brinkley, *The Reagan Diaries*. [↑](#footnote-ref-69)
70. Abelson, “The Politics of Friendship,” p. 10. [↑](#footnote-ref-70)
71. See, e.g., Jeremey Kinsman, "Who is my neighbour? Trudeau and foreign policy." *International Journal* 57 no. 1 (2002): pp. 57-77. [↑](#footnote-ref-71)
72. The relationship between the two certainly could have been worse. Abelson, “The Politics of Friendship,”pp. 9-10 provides a brief overview of the at-times-comical relationships between Canadian and American leaders during the early NORAD years. In particular, Trudeau was despised by Nixon. [↑](#footnote-ref-72)
73. See Jockel, *Canada in NORAD*, pp, 118-119 for a brief overview, including the opinions of historians who think Trudeau did it in part to help earn some favour with Reagan. Crosby, *Dilemmas in Defence Decision-Making*, pp. 179-181 recounts the controversy and discusses the open letter Trudeau published in Canadian newspapers defending the decision. As an aside, the letter evidences a strong rebuttal to the charge that Trudeau was merely neutral between the two sides in the Cold War conflict. [↑](#footnote-ref-73)
74. Kinsman, “Who is my neighbour?” The quote comes from page 6 of the digital copy, which does not necessarily correspond to the page numbers of the original journal publication. [↑](#footnote-ref-74)
75. Six of the DEW Line stations, located at Point Barrow and Barter Island in Alaska, and Cape Parry, Cambridge Bay, Hall Beach, and Cape Dyer in Canada, were “main” stations, responsible for all data processing and communications back to command, and were staffed by six officers and 40-50 civilians. The remaining stations were either “auxiliary,” staffed by 16-18 civilians and with equivalent radar capability to the main stations, or “intermediate”, staffed by 4-5 civilians and with reduced radar capability. See Cox, *Guarding North America*, pp, 54-55. [↑](#footnote-ref-75)
76. Shadwick, “NORAD,” 243. [↑](#footnote-ref-76)
77. See e.g., Slayton, *Arguments that Count*, pp. 53-54, and Defense Advanced Research Projects Agency, “Phased Array Radar,” accessed 30 October 2022, https://www.darpa.mil/about-us/timeline/phased-arrays. [↑](#footnote-ref-77)
78. See e.g., Frederic Lasserre, and Pierre-Louis Tetu, "Russian Air Patrols in the Arctic: Are Long-Range Bomber Patrols a Challenge to Canadian Security and Sovereignty," *Arctic Yearbook 2016*: pp. 305-327, for details and discussion. [↑](#footnote-ref-78)
79. While hypersonic weapons have been described as nearly a “Sputnik moment” by the Chairman of the Joint Chiefs of Staff, scientists have argued that hypersonics are more “evolutionary” than “revolutionary.” See Ashley Burke, 2021. "NORAD commander warns Canadian officials about the threat posed by hypersonic missiles," *CBC News*, 30 November 2021, for the quote from the Chairman, and for scientific analysis, see David Wright and Cameron Tracy, "The Physics and Hype of Hypersonic Weapons," *Scientific American*,1 August 2021, accessed 30 October 2022, https://www.scientificamerican.com/article/the-physics-and-hype-of-hypersonic-weapons/, and Union of Concerned Scientists, "New Analysis Finds Hypersonic Weapons Offer Few Advantages over Exis`ting Missile Systems," *Union of Concerned Scientists*, 5 May 2021, accessed 30 October 2022, https://www.ucsusa.org/about/news/new-report-hypersonic-weapons-offer-few-advantages. [↑](#footnote-ref-79)
80. Tracy Wilkinson and Sergei L. Loiko. "Here is what Joe Biden actually did in Ukraine," *Los Angeles Times*, 5 October 2019. [↑](#footnote-ref-80)
81. Is it possible to even imagine Trump agreeing to an 88/12 construction cost split? [↑](#footnote-ref-81)
82. Why does it work now when it failed in the past? Previous attempts at north-facing OTH radar designs allow their beam to be steered only in azimuth, such that whenever the beam looks north, auroral clutter (visible to the eye as the “Northern Lights”) obscures detection of potential targets. The modern system under development at Defence Research and Development Canada (DRDC), a successor to the DRB, involves an array that permits control of the beam in both azimuth and elevation. This allows the beam to bounce off the ionosphere *before* the regions containing auroral clutter, substantially improving the ability of the radar to “see” targets in the north. See e.g., Ryan Riddolls, "A Canadian Perspective on Arctic and Polar Over-the-Horizon Radar," *2022 IEEE Radar Conference*, (2022): p. 1-6. [↑](#footnote-ref-82)
83. Andrea Charron and James Fergusson, *NORAD: In Perpetuity and Beyond* (Montreal & Kingston: McGill-Queen's University Press, 2022). [↑](#footnote-ref-83)
84. Charron and Fergusson, *NORAD*, p. 81. [↑](#footnote-ref-84)
85. Charron and Fergusson, *NORAD*, p. 80. [↑](#footnote-ref-85)
86. Charron and Fergusson, *NORAD*, 4 pp. 9-51 and 81. [↑](#footnote-ref-86)
87. Department of National Defence, *Strong, Secure, Engaged*, (Ottawa: Department of National Defence, 2017), p. 80. [↑](#footnote-ref-87)
88. Ryan Dean and Nancy Teeple, "Introduction: The Missing Chapter of Strong, Secure, Engaged," in *Shielding North America: Canada's Role in NORAD Modernization*, eds. Nancy Teeple and Ryan Dean (North American and Arctic Defence and Security Network (NAADSN), 2021), pp. xi-xxiv. [↑](#footnote-ref-88)
89. Charron and Fergusson, *NORAD*,p. 85. [↑](#footnote-ref-89)