

## Area Air Defence as a Network Enabled Capability for the New Norwegian Frigates

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### ABSTRACT

*The new Norwegian Nansen-class frigates lack an organic long range air defence capability. Basically, this is a result of the high cost of such a system in relation to the limited resources of a small nation. This lack of capability is currently perceived to be one of the most serious shortfalls of the class. A well-known non-organic solution of this kind of shortfall is to use frigate-controlled fighter aircraft to provide area defence coverage – thus to some extent separating the sensor from the shooter capability. In this contribution the consequences of adopting such a solution as the only long range frigate air defence are discussed.*

*The discussion is organized as a cost/effectiveness comparison between a traditional organic long range air defence system and the Network Enabled Capability (NEC) solution (frigate-controlled fighter aircraft). The comparison is based on scenarios/cases, where several technical and operational factors are considered.*

### 1.0 INTRODUCTION

The Royal Norwegian Navy (RNoN) is procuring five Fridtjof Nansen-class frigates (FN-class) that will be commissioned during the next few years. Compared to the Oslo-class frigates that they replace, they

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represent a significant improvement of capabilities within all warfare areas. The ships are built at the Navantia shipyard in Ferrol, Spain, with Lockheed Martin as subcontractor for combat system integration. Kongsberg Defence and Aerospace are responsible for a major part of the combat system, integrating all under water and surface sensors and weapons. This includes the newly developed Naval Strike Missile (NSM).

Some of the main tasks allocated to the Norwegian surface flotilla are to

- maintain sea control in Norwegian territorial waters
- exercise Norwegian sovereignty
- protect sea lines of communications
- contribute in NATO and UN operations

The new frigates will be an important element in execution of these tasks.

The Nansen-class was originally intended and specified primarily as Anti Submarine Warfare (ASW) frigates with self-defence capability against missile and torpedo threats. Through the bidding process the winning constellation of Navantia/Lockheed Martin/Kongsberg was able to offer a system that in some respects exceeded the initial requirements. In particular the Aegis combat system gave the ships better air defence performance than anticipated. The thinking about the role of the frigates has therefore evolved and resulted in additions to their communications and C2 outfit. This now includes Link-16 tactical data link and multi-function consoles supporting the control of fighter aircraft. Based on these capabilities, the class is now referred to as a multi-role frigate.

The main capability shortfall of the Nansen-class compared to other modern air defence frigates is the lack of an area air defence capability. It is currently only fitted with the ESSM surface-to-air missile. This has a limited range and only provides a point-defence capability. The aim of this paper is to discuss two alternative implementations of FN-class area air defence. We compare advantages and disadvantages of a possible upgrade with long-range air defence missiles (such as Standard Missile 2) with a solution based on the use of fighter aircraft on direct support (e.g. frigate controlled F-16s).

An air-to-air refuelling capacity would be very profitable for the fighter aircraft solution. However, Norway does not have this capability, and the scenarios considered below are mainly national low intensity ones. Of this, air-to-air refuelling is not considered in the discussions.

Many of the national tasks of the class entail operations in the littoral areas. It is in these types of operations the second option is especially relevant. The discussion below cover several aspects of using fighter aircraft (F/A) as an area weapon for the FN-class. The procedures and tactics of doing this will be based upon already established NATO and national procedures. Other nations may have a different approach to similar challenges due to differences in resources, topographical conditions, existing infrastructure, technical solutions or strategic focus.

## 2.0 THE CHALLENGE

In order to operate a naval force, air superiority will (to some degree) generally be required. In the presence of an air threat, this has to be managed either by naval air defense assets or by typical air force assets (combat air patrol or surface to air missile). Fundamental in this context is risk assessment – for each military strategy on air defense, an associated risk exists, and the risk can seldom be zero. Typically, in a low intensity situation, the tolerated risk level is very low. On the other hand, in a high intensity situation a military force is more prone to accept risk.

The new Norwegian Nansen-class frigates do have short range air defense, but lack an area air defense capability. The point air defense (Evolved Sea Sparrow Missile, ESSM) constitutes a self-defense capability for the frigate only, this means that protection of other units (i.e. other vessels or high value units) is hard to ensure unless they are placed close to the Norwegian frigate. Also within a naval force (e.g. task group), typically the smaller vessels do not have own air defense capabilities, which mean that someone else (e.g. the new Norwegian frigate) has to provide this. This capability could be solved by organic area air defense. Two available systems are Standard Missile and ASTER 30. The frigate is already prepared for launching Standard Missile 2.

Another way of implementing the area air defense capability is to use F/A on direct support. This could be done either by a Combat Air Patrol (i.e. an F/A circling over the area), or by a land based F/A on high alert. The Norwegian frigates are manned and equipped, in order to be able to control F/A, which makes this area air defense solution attractive. Also the weapon capability of a present F/A is integrated into the frigate's combat management system (AEGIS). This makes a frigate controlled F/A to an integral part of the frigate weapon suite. This alternative way, due to the land based F/A, totally depends upon a coast in the vicinity of the threat: If the threat shows up too far away from the coast, most or all of the limited F/A time in air is spent in transit. This means that the alternative is relevant solely in the littorals.

The air domain sensors of the frigate, and especially the radar (AEGIS SPY-1F), do possess a high capability: The phased array radar, enabling scanning almost simultaneously in all directions, along with the high output energy enables early detection. This capability is very suitable for controlling of F/A.

The current Norwegian Navy doctrine for handling a present air threat in a national low intensity scenario is to "outsource" this task to the Air force. Of course the ESSM capability will be applied, but this is as mentioned above limited to protect the frigate itself. Other own units present like fast patrol boats, mine counter measure vessels and high value units (HVU) will not obtain sufficient protection from the frigate.

When contributing within an international naval force, e.g. Standing NATO Reaction Force Maritime Group 1 (SNMG 1), the new Norwegian Frigates do not expect to take on the duty as Anti Air Warfare Commander (AAWC), i.e. responsible for the air threat protection of an international naval force. On the other hand, by means of the mentioned new Norwegian Frigate capabilities: Ability to control F/A, ability to integrate the F/A weapon capability, and also facilities for hosting an embarked staff (up to 20 persons), the frigate could also take on the AAWC duty.

In the future, frigate controlled F/A as a means of implementing area air defense could serve as the permanent Norwegian solution for handling an area air defense threat. As a small nation, Norway can't have a multitude of expensive and advanced tools in its own toolbox, but can take advantage of the Network Enabled Capability (NEC) thinking, in order to solve a challenge by use of already existing resources.

### **3.0 AN ALTERNATIVE WAY OF TACKLING THE AIR THREAT – F/A ON DIRECT SUPPORT TO FRIGATES**

The standard way to implement area air defence in the neighbourhood of a frigate would be to put this capability on the frigate – this is easily done to the new Norwegian frigates. On the other hand, it is extremely expensive, seen in relation to a small nation's defence budget. In this context it makes sense to consider alternative ways of solving this challenge.

The alternative considered here, namely frigate controlled F/A, is also expensive, but in a totally different way. Whilst the organic air defence is expensive to procure, the frigate controlled F/A do almost involve no new procurements (taking for granted that a national F/A capability exists). On the other hand, having

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the organic system onboard, it is almost free to sustain alertness over a long period of time. To sustain a similar degree of alertness by means of the frigate controlled F/A involves extremely high resource usage.

The readiness characteristics of the two alternatives differs a lot: Having organic area air defence, the frigate possess proper readiness as long as the frigate is suitably manned. On the other hand, the frigate controlled F/A solution has an in-built response-time which is necessary to establish a proper readiness.

Already, a similar approach to the alternative of frigate controlled F/A is regularly trained within Norwegian F/A forces. To operate the NATO resource AWACS (Airborne Warning and Control System) as the controlling unit of Norwegian F/A is a standard procedure. This demonstrates that to control Norwegian F/A by an external unit (i.e. not a Royal Norwegian Air Force unit) already is achievable.

Our alternative to a ship-based missile solution includes these components:

- A potent or present air threat, or the expectation that an air threat will materialize
- Threatened units (e.g. HVU) on the sea lacking (organic) air defence systems
- A new Norwegian frigate close enough to the threatened units, capable of controlling F/A and building a Recognized Air Picture (RAP)
- Available F/A, either land based on high alert or airborne above the threatened units, i.e. Combat Air Patrol (CAP)
- National doctrine, tactics and procedures has to be established
- Regularly training has to be executed

This is not considered to be an “omni-scenario” solution, but would apply to scenarios where the Norwegian armed forces can’t expect international reinforcement (e.g. low intensity operations).

Navy and Air Force cooperation in this way is not at all new – large nations are training in this manner regularly. The new thing is to **plan for this as the permanent and only - not only a supplementary - solution.**

This could be an attractive solution for Norway in a littoral setting. At best the available military resources will remain constant, while high-tech military assets steadily grow more expensive. In future, small nations have to narrow the spectrum of force elements in order to be able to sustain the remaining ones.

The solution is an example of NEC where platforms solve a mission in cooperation based on interoperable procedures and technology.

### 3.1 Technical factors

Most of our problem is related to change of doctrines – how do we want to solve our military challenges in the future? Despite this, some technical factors are also identified to have considerable impact on the viability of the solution, namely: Communications between frigate (FF) and F/A, F/A range/time on station, F/A reliability, F/A usage and FF radar capability. These will be discussed below.

This discussion is also relevant when considering alternative procurement options for new F/A. Depending upon the assessed relative importance of these factors, the F/A candidates will be scored differently. The factors are mainly concerned about F/A features. This is merely a result of the fact that many of the challenges in our solution are placed within the aircraft.

*Communications between FF and F/A* is crucial in order to carry out this task. The fighter controller at the frigate needs to communicate with the F/A pilot on a second-to second basis. This is both voice- and data

communication. Track data of air objects, command messages as well as status reports from other own units comprise the data communication. Link 16 is available and relevant in this context, and provides jam-resistant and secure data and voice communication. A challenging factor here is to stay connected – Link 16 depends upon line of sight communication, and the F/A easily drops below the frigates horizon. This challenge can be solved either by SATCOM or airborne relay.

*F/A range/time on station* is a key factor: The main disadvantage of our “frigate controlled F/A” solution is the instant resource usage, and the big driver here is the short “on station time” (i.e. the productive time during a sortie). The total time in air during a sortie is short for an F/A – for the Norwegian F-16 this is assessed to be approximately 3 hours. These 3 hours are divided into “time on station”, transit and reserve fuel. By assuming 15 min transit in each direction and 30 min reserve, we get 2 hours on station per sortie. In this context the transit time is waste of resources, and amounts to  $30 \text{ min} / (2 \text{ hours} + 30 \text{ min}) = 20 \%$ .

*F/A reliability* depicts the availability of the aircraft. In one of the options discussed below, having the F/A on high alert, this reliability (i.e. lack of) is tackled by allocating 3-4 aircraft in order to ensure that at least 2 of them are available at any time.

*F/A usage (manoeuvring)* is directly connected to the “time on station” factor. There is a trade-off between manoeuvrability and endurance, and in this F/A usage it seems to be (compared to general preferences) more focus on endurance than manoeuvrability. Crucial factors here are speed, acceleration and stationing/altitude.

*FF radar capability* (AEGIS, SPY-1F) is a critical factor in this situation – the ability to build a picture (Local Recognized Air Picture) is necessary in order to control the F/A. Depending upon the distance from the coast, the frigate radar can cooperate with land based radars or constitutes the only radar resource. A main challenge (like for all surface based radars) is to detect the involved units, i.e. the threat and own F/A: Very easily these objects drop below the horizon and can’t be detected. In this context the elevated F/A radar provides a complementary capacity due to its elevation and high mobility.

## **3.2 Operational factors**

In this paragraph the operative aspects of our discussion is found. Most of the discussion is devoted to the alternative of F/A on direct support to the frigate. This is merely a result of the inherent flexibility and complexity of this alternative.

### **3.2.1 Deployment**

Using F/A in defence of a naval force is not a new idea. However there have been different approaches to how to make it the most effective.

In the RNoN, embarked Fighter Controller is a new concept, developed due to the ability of the FN-class, and the acknowledgement of the need for an area air defence for a navy operating in the littorals.

Our discussion assumes deployment along a friendly coastline, and Norway is used as an example, but many of the principles can be used along other areas of operation as well.

The threat can be both a traditional one, with hostile aircraft armed with air to surface missile belonging to another nation, and unconventional one, such as an asymmetric threat. Some of the considerations below will fit better to one of the threats than the other, and the effects of F/A as area weapon for the FN-class will depend on the scenario.

Two of the biggest challenges for a force without organic fighter support is to obtain a high degree of coverage (time on station), and a short reaction time for land based F/A. A 24/7 coverage is preferred,



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however this will in most situations be unrealistic. Because of the opportunity of the attacker to choose the time of the attack, he will normally not cooperate with the on station time of own defensive air to air assets. Therefore warning time (detection of the threat aircraft) versus reaction time is an essential issue.

Operating along a friendly coastline gives a great advantage due to the fact that transit ranges can be reduced having operating bases close to the area of operation. For a static scenario, operating in the same area over a prolonged period, forward operating locations (FOL) may be established, cutting down on transit times. However the number of FOLs will be limited due to the amount of personnel required to conduct logistic support and the storage of weapon for re-armament. The transit ranges could be even shorter if using civilian airfields with refuelling opportunities as FOLs. An example is presented in Figure 3.1, where the frigate is positioned outside the west coast of Norway near Bergen.



**Figure 3.1 Transit ranges from Oerland (Base) to Oil installations off coast Bergen ~ 250 nm or ~ 30 min. Transit range from Flesland (FOL) to Oil installations off coast Bergen ~ 50 nm or ~ 6 min. The transit times represent time in air and do not include response time at the ground**

With the F/A on readiness of 15 min, and a requirement that hostile aircraft should be confronted at a distance of 50 nm, this will mean that a hostile aircraft with an average speed of 400 kts have to be detected at a range of 200 nm if own F/A is stationed at the airport of Flesland, or 400 nm if they are stationed at the Oerland air force base. While 200 nm is an acceptable distance to detect and classify aircrafts with frigate sensors, 400 nm is not. Dependent on the mission and the accepted risk, this could mean that if F/A are stationed at Oerland, they would have to be airborne at all times. The above calculations are visualized in Figure 3.2 below.



**Figure 3.2 Minimum detection ranges of the incoming small airplane threat, assuming that F/A is located either on a regular base or at a forward operating location**

A stationing on a forward operation location will not only reduce the transit time significantly, it will also greatly enhance the time the F/A may be on station (given refuelling at FOL). The restriction on maximum fly time/rest periods may however restrict some of the use.

Using F/A weapon in an engagement is also a logistic advantage. While the navy has the advantage to stay on station for a long period of time, the re-supply of missiles is often a time consuming necessity, and they are dependent on harbour facilities, while the F/A will return to base anyway. This will give the F/A the opportunity to a regular re-supply from base without taking away operational time.

### 3.2.2 Sensors

In this paragraph, the sensor capabilities of the F/A in combination with the FN-class are discussed.

Naval sensors often has a long range and 360 degrees coverage, however they are limited by the horizon. The F/A often have a medium range, and no or little limitations with regards to the horizon, but they are limited to the coverage of a sector.

When two combat systems are cooperating, there are occasions when one or the other doesn't have to use active sensors. If the counterpart has an Electronic Support System, there could be advantages to keep one of the two sensors silent. One possibility would be for the F/A to remain silent, while the FN-class produce long range warning. This in combination with smart stationing or high alert on a nearby airfield may give a bonus effect due to the possibilities of surprise. F/A may be stationed/transiting off threat or in areas where an opponent have no, or bad radar coverage, and could be vectored into a position of advantage by the FN-class.

The F/A sensor could also be tasked for detection of specific threats or as sensor gap filler in a specific sector.

Operating from a ship in a strict rules of engagement (ROE) environment, one of the hardest challenges is the need to be sure of doing the right thing when exercising force against an unknown air contact. In many

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circumstances only visual identification is good enough to be allowed to use deadly force. This gives rather little battle space if the only visual sensor is a lookout. Surface based assets have a limited range of measures at hand before having to choose between lethal forces or letting the possible threat come possible too close. This is inadequate when faced with the uncertainty if a civilian small aircraft doesn't adhere to air traffic rules (e.g. monitoring right frequencies or unaware entering zones with restrictions) or if it is an asymmetric threat aimed at your ship. By cooperating with F/A, they will not only be able to do a visual identification, but they are on the spot, and may show presence (using radio, interception, warning shots, etc), and thus eliminating the possibility for a misunderstanding.

The previous paragraphs has been considering the F/A as area air defence and elevated sensor for the frigate, however the F/A has also a good capability for being a surface sensor, both visually, and especially with new targeting equipment or integrated reconnaissance equipment. Even though other aircraft, like the Maritime Patrol Aircraft, is specialised in surface warfare and picture compilation on the surface, the F/A could do a good job in following contacts of interest, monitoring focal points, or search and track fast attack crafts, while keeping its inherent capability of high level self defence. This could be especially useful when operating along an opponent's coastline. In this context the F/A could also be a weapon by carrying suitable bombs against small crafts.

### 3.2.3 Other operational aspects

Comparing the two weapon systems, long range (organic frigate) surface to air missile (SAM) and F/A, they have some advantages and disadvantages. The range of an engagement may happen at an even longer distance when using F/A, however, given the range of modern long range SAM systems, this gives little extra advantage. One shortfall of the F/A may be the probability of hitting modern, small radar cross section (RCS) sea skimming missiles. This means that no matter how good a F/A solution will be, the naval ship should keep a minimum capability of self- or short range defence, tailored to the threat that the F/A will have difficulties to counter.

Even though there are several good arguments to use the F/A as an area weapon for the FN-class, there is some major concerns. Some of the disadvantages are the fact that they normally cover only one threat axis, low probability of kill on low RCS sea skimming air to surface missile or surface to surface missile, heavily dependant upon closely located airbases, and the on-task time. While both the disadvantage of one axis, and on-task time can be countered by dedicating even more F/A, this poses the most difficult question. What priority and how many F/A can one get? The priority will shift dependent on the scenario and the overall goal of the nation. The maximum number of F/A is restricted to what the nation has in its inventory, or the NATO alliance has brought forward for support. Given that having 2 F/A in the air for a week you need a pool of about 10 to 20 F/A deployed to the operating location. If you also need more redundancy because you for instance expect a high number of intercepts, this number may be twice as big. On the other side, if considering on using F/A as the area weapon for the FN-class, and the naval task doesn't have a top priority, the navy might find itself completely deprived of this resource. This might be the best for the overall operation, but leaves the navy vulnerable and totally without an area weapon.

### 3.3 Resource usage

The frigate controlled F/A solution has basically two implementations: 1) F/A on station, i.e. airborne or 2) on alert, i.e. land based. These two options will be discussed separately. Of course a lot of indirect resource usage will show up in this context, like e.g. extra training. To keep it simple, those factors are not taken into account.

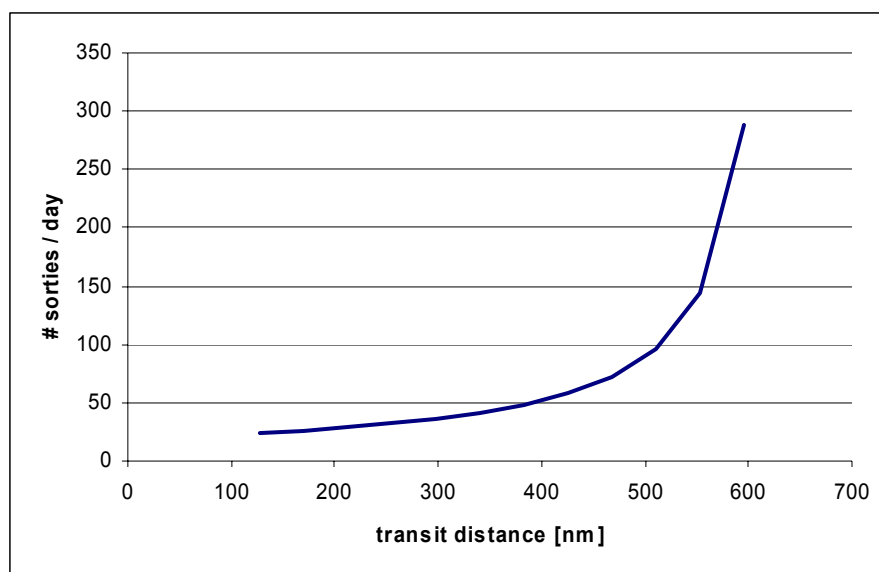
*Option 1, i.e. F/A on station* implies that the F/A is airborne some place above the threatened unit(s). This kind of operation is called CAP. Typically two airplanes operate together (2-ship) when doing this task. The resource usage calculation is a function of



- distance between air base and CAP
- number of available air craft
- number of available pilots
- remaining available hours at each aircraft before heavy maintenance (i.e. maintenance where the aircraft will be unavailable for several days)
- maintenance due to sudden system problems

If we assume a scenario where the Norwegian oil and gas installations in the North Sea are threatened from the air (e.g. small aircraft), a F/A will spend approximately 15 minutes in transit time between a land base and the CAP. This gives an effective available time on station about 2 hours (for F-16). For one day (24 hours) we then have to spend 12 consecutive 2-ship CAPs. Further calculations along these assumptions imply that a pool of about 10 to 20 aircraft can run the CAP for a week (i.e. 24/7) before the pool run out of available hours. I.e. in accordance with today's way of operating the aircraft, we assume that the first bottleneck that shows up is heavy maintenance.

As mentioned above, the frigate controlled F/A solution heavily depends upon a coast having a friendly airport/airbase not too far away from the CAP. In Figure 3.3 below, the transit time is varied between 15 min (or 130 nm) and 70 min (or 600 nm). At a transit time of 75 min, there is no remaining time on station. These computations use the same F/A speed as assumed in Figure 3.1, i.e. Mach 0.85.



**Figure 3.3 Number of sorties needed per day for varying transit distances**

As can be seen from Figure 3.3, our alternative solution is doable out to a transit distance of about 400 nm. Outside this “littoral region” the resource usage grows extremely fast.

The pilot usage will also be significant for this option. Applying Norwegian rules, a pilot can be airborne for maximally 7 hours/day. Spending 12 2-ship CAPs for seven consecutive days, gives a theoretically minimum size of the pool of pilots equal to about 12.

*Option 2, i.e. F/A on alert* implies no extra aircraft usage until the threat materializes. The only direct consumption is pilot-hours. By assuming a two-ship CAP (i.e. a CAP executed by two aircrafts) available

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for sure, typically 3-4 aircraft are needed in order to carry it out. This is based on experiences of small malfunctions showing up at take off time (called snags) which can hold back the aircraft. The probability of snags varies a lot, but 20 % can be used as a representative number, which implies that spending 3 or 4 aircraft are reasonable in this case. If we assume optimistically that each pilot can be on duty 12 hours per day for the actual period (some days), this gives a minimum size of the pool of available pilots equal to 6 – 8 pilots. These pilots have to be well trained in order to do this mission, which means having at least 180 hours of relevant flight hours within the last 12 months (NATO rules). In addition, a pool of pilots has to be “on-call” if the CAP is activated. Some other expenditure will also accrue (technical support on the aircraft, base support, etc); however this is not specified in more detail. This alert based option is very attractive because the resource consumption is very low as long as the threat doesn’t show up. The main drawback comes from its applicability – this option is based on the assumption that a timely warning can be expected. This is a strong assumption, and in a lot of situations this will not be applicable, because either the threat is positioned too far away from the coast and/or no air base exists in the coast area where it’s needed.

It is worthwhile to mention that when calculating on use of F/A using strict figures of on-task time, this may not be sufficient in real life. When using F/A on intercept missions, high speed shadowing or other fuel consuming tasks, the actual on-task time may be much lower than the average calculated. Also, if the scenario is complex it might be a precondition to have extra F/A on short readiness or even, in the air.

### 4.0 ECONOMIC CONSIDERATIONS

The structure of the costs for the two different approaches (organic area air defence vs. frigate controlled F/A) are very different.

#### *Organic area air defence (Standard Missile 2)*

- Life cycle cost: 500 mill USD. The life cycle cost-estimates include all costs associated with procurement, maintenance, storage, upgrades and any possible integration costs
- Running expenditures: Relatively small - 1 missile costs approximately 1,3 mill USD

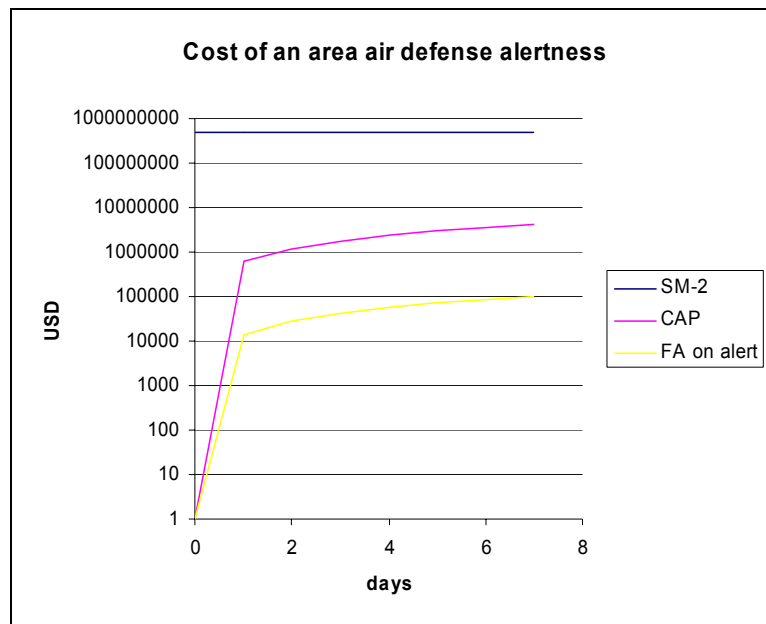
#### *Frigate controlled fighter aircraft – airborne*

- Life cycle cost: No significant ones – all technology available
- Running expenditures (per day): 12 x 2-ship sorties, each involving 2.5 hours in air = 60 hours/day. An approximate marginal cost for an hour = \$ 10,000. This gives a marginal cost of \$ 600,000 per day

#### *Frigate controlled fighter aircraft on alert – land based*

- Life cycle cost: No significant ones – all technology available
- Running expenditures (per day): 7 pilots continuously on duty, each obtaining \$ 400/day extra. Extra expenditure, estimated to 4 times the pilot cost. This gives a total variable cost of \$ 14000 per day

As can be seen from above – the economy varies a lot between the different options. This is summarized in Figure 4.1.



**Figure 4.1 A comparison of the cost associated to area air defence alertness implemented in three different ways. Notice the logarithmic behaviour of the vertical axis**

The economic considerations for the two F/A based solutions assumes that the options will be activated only one time during the lifetime of a Standard missile 2 system (30 years). This is a reasonable assumption when considering national scenarios. Costs related to extra training for the F/A based solutions is not taken into account. This is merely a result of lack of knowledge so far, i.e. it is at the moment not yet known how much training – in all cases – Navy and Air force will do together. Finally the costs of the F/A based options do not include extra expenditures related to upgrade of a civilian airport (FOL). This cost depends a lot upon the status of the civilian airport, and of this not taken into account.

## 5.0 CONCLUSION

Norway has procured five new Nansen-class frigates, of which the first one is about to enter operational evaluation. So far they do not possess an area defence capability. Two alternative realizations of this capability are discussed. The first one is to assign fighter aircrafts to the frigate on direct support. The other is to equip the frigates with an air defence missile with sufficient coverage (e.g. Standard Missile 2). Such an upgrade represents a substantial investment, and is not easily funded within the restricted resources of a small-nation navy. In this context the pros and cons of the alternative solutions has been considered. These are summarized in Table 5.1.

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**Table 5.1 Pros and cons of the two alternative implementations of frigate area air defence**

	Organic area air defense (SM 2)	F/A on direct support to frigate
Dependant upon a relatively close coastline	Not	Heavily
ID capability before engagement	Weak	Strong (Visual ID)
Investment costs	Very high	Almost 0
Running expense	Almost 0	Very high