THE DRAMATIC HISTORY OF SOVIET NUCLEAR SUBMARINES - THE FEATS, FAILURES AND HIDDEN CATASTROPHES OF 30 YEARS

INTRODUCTION - USA - USSR: The Birth of the Atomic Submarine

After the Second World War and the bombing of Hiroshima, the USA were developing their atomic industry well - at the end of the 40's Stalin threw everything into trying to catch up, jeopardising the Russian economic development.

The building of the first soviet submarines "Decembristes" (created by Boris Mallnini and Mikhail Roudnitski) started in 1926, followed by the "Brochets" several years later. After these came "Type 5" used in World War 2 - at the start of the war USSR had 218 submarines. As the development of atomic powered submarines started, the US took the same outline shape as for those with diesel power eg Nautilus, whereas the Soviets took the completely opposite approach and created a form optimal for steering and diving - rather than good navigability on the surface. One of the leading figures involved in Soviet submarines was Peregoudov, a country boy who later went to the Dzerjinski Technical Maritime School of Leningrad. For the first nuclear submarine he was responsible for the construction of the submarine and it was his decision to oppose the US views. Dolleyal made the reactor, Gassanov the steam generator and the overall responsibility of the project was given to Zaveniaguine.

When Kruschev came into power he reduced the money put into nuclear submarines to try and help the economy. Stalin had wanted to build 1200 submarines but this was cut to 240 of type "K" or "Whisky" in Western terminology and only 20 of the foreseen 560 "Romeo", the following series were built.

In the development of the nuclear submarine Russia was 4/5 years behind the USA and it was in 1967 that the soviet SSBN "Yankee" reached the same standard as the first generation of US SSBN. However, opposite to Polaris, which used solid fuel, the soviet missiles worked on liquid fuel.

The 2nd generation of soviet atomic SSBN "Delta" had 12 intercontinental missiles sensitive enough to reach US territory from soviet water. These still used liquid fuel and it wasn't until around 1981 that the change to solid fuel was finished. In armament and detection they were still far behind the US though. An American researcher, T Stefanik studied two submarines with comparable performances under parallel navigation conditions - the Los Angeles (US) and the Victor III (USSR). These showed that the American vessel could only be detected at a distance of 1 to 25 miles away at great depth, whereas the soviet was detected at 20 to 500 miles.

The "Typhoon" built to counterbalance the US "Ohio" was the biggest type of submarine in the world, 170m long, 25m wide, 26M high, with a displacement of 25,000 tonnes, and was specially built to operate in the arctic ice-flows, being capable of breaking through over a metre of ice. They had a steel casing containing 2 hulls of hypersolid titanium each of diameter 10M. They were separated by three other solid units, one at the bow with 6 anti-surface torpedoes and some 10 torpedoes and anti-surface torpedoes, one at the stern, which was the rudder compartment and the other unit which was the command post. It had two water cooled reactors each of 190 Megawatts and two turbines of 80,000 shp allowing it to reach speeds of 30 knots when submarinemerged. The crew was made up of 50 officers, 80 petty officers and around 40 sailors. It even had a greenhouse, sauna, swimming pool and aviary with parrot. This was the first soviet submarine where the missiles were of solid fuel. Each submarine had 20 RMS SZ missiles (SSN20 in Western terminology) of 10 warheads possessing a high reliability function and a high fire precision. The missiles weighed close to 100 tonnes, were 16M high and had a diameter of 2½ M and were capable of destroying targets over 9000 KM away.

Unlike the US submarines the missiles weren't launched using a "red button", but it was necessary to turn two keys one of which was held by the commander of combat unit number 2 and the other by the commander of the vessel. The flight programme was recorded on a magnetic strip. At no time were the two officers in a position to decide to launch the missiles themselves.The computer on board didn't give the order until it had received the coded signal from President Yeltsin and this code was compared with that in its memory before allowing launching preparation. At that time the commander of the vessel could introduce the magnetic strip into the system and put in some signals known only to him - the authenticity of which was checked by the computer. This system prevents the launching of non-authorised missiles and the crew were ignorant as to which targets the missiles were aimed at.

Chapter 1 - The First Swallow

Discusses all the procedures gone through to appoint the crew by Lev Giltsov and Boris Akoulov. Lev Giltsov had previously been on the "S61" whose performance was largely due to the knowledge of the German engineers in prison. The crew were then all given a course on the operation of a nuclear reactor which took place at Obninskoïé, later Obninsk, the world's first nuclear power station.

The soviet submarine had two reactors (USA only 1) and also had higher parameters than that of the US - 200 atmos pressure in the steam generator and a temp of more than 300°C. This allowed a speed of 5 knots more than the USA submarine when submarinemerged. It could reach 25 knots but at that speed the acoustic apparatus no longer worked and on the surface they couldn't go at more than 16 knots without risking a nose dive. Discusses the design problems they had to overcome.

Practically all the electricity produced at Obninskoïé (5000 kw) was used to feed the experiments for the submarine. Almost every time the reactor was operated it leaked radioactive gas and vapour. The most serious accidents were repaired by the prisoners at the on-site penitentiary. All the crew received massive doses of irradiation - for example when they first started up the reactor, the radioactive water in the reactor squirted out as the RPV head had been badly reshut - they were all given rubber gloves and cloths and just sponged the water up into metal buckets. All the air at the site was so radioactive that the dose meters that crackle, crackled hysterically at the gate-house.

Discusses the double life they had to lead - naval officers at Moscow and technical staff at Obninskoïé. In January 1957 they finally saw the submarine up at Severodvirsk (a town so secret that not even the soviets knew about it!)

Chapter 2 - Trials at the Quay

The first trials were to test all the installations on the vessels - these were of two types: fixed point and at sea.

Describes the launching of the vessel from the "dockyard" and all the ceremonies that went with it.

To avoid collisions between two submarines in the trials, the trial zones were polygons. The only real risks were from merchant ships, so the submarine was accompanied by an escort vessel. If a ship appeared on the horizon, the escort vessel hid the submarine with its hull, and if the ship approached the escort raised a smoke curtain so that the submarine couldn't be photographed. The diving trials were supposed to last ten days, but on the third, one of the primary circuit pumps broke down. Due to the high level of radioactivity they returned back to the base to get it repaired as the protective layer of lead and chlorine trifluoride first had to be dismantled. They also discovered they were losing water from the turbines due to leaks, this became so bad (critical) that they had to get the dockyard to build them a special stainless steel tank to hold pure water. The other major setback of this trial was that they broke the periscope on a floating log and this refused to go down. The steam generators all leaked and constantly had to be replaced.

They estimated that the average man could take, without too many problems, doses of 100 times the radioactivity safety limit, so it was to this level that they worked. It was only when all the compartments in the submarine got to this level that they finally surfaced to ventilate the submarine.

The last two trials took place in December 1958 - that of diving to the maximum depth possible and that of navigating at full speed for 48 hours without surfacing and without ventilating the compartments.

Three more submarines were then built in the same series as the K3 - the K5, K8 and K14.

All the crew were decorated - the sailors received the Ouchakov Medal, the officers the order of the Red Flag, second in command (Lev Giltsov) and Boris Akoulov got the order of Lenin and the commander got the title of "Hero of the Soviet Union" with the order of Lenin and the Medal of the Star of Gold.

Chapter 3 - To the Top of the Globe

The Russians spent a lot of time and money on exploring their polar waters both before and after the war as they began to realise it had a lot of potential. At the end of the 50's the USA had the first nuclear submarines navigating in the ice floes, some being capable of attacking Soviet territory from there, so it was no surprise that the soviet authorities decided to build nuclear submarines with some haste. Faced with all the problems of navigating in Arctic waters the US Navy carried out many important tests. Unlike the USSR these weren't hidden and so the USSR had at its disposal all the US information, putting them at a great advantage, as they already knew which errors not to make and which problems they would have to overcome, enabling them to think about things in advance.

The first Soviet navigation in the ice floes was accomplished by the submarine "Silure" in 1905, which was actually built by An American company. Their first navigation under the ice floes took place in 1908 by the submarine "Muge" also built by the USA. It was only after the October Revolution that navigation in the ice was once more pursued, the first Missions being accomplished in the 30s by the Decembriste and Brochet submarines. Just after the war the soviet diesel submarine L13 travelled 468 miles under the ice-floes in 19h 43, this record only being beaten by nuclear submarines.

The K3 carried out all the tests of the new systems that would be needed for a soviet submarine to reach the north pole. In the end it was this submarine that was chosen to carry out the mission. Kruschev came to visit the submarine and their "present" to him was that the submarine would be ready to leave on his visit. The major problems on the submarine were quickly repaired, but the smaller ones would have to be repaired on the journey. The crew were to reach the 85 degree latitude and report back to say how their trip so far had been and to find out if they were allowed to carry on. They finally reached the North pole on the 17 July 1962.

On their return they were supposed to carry out some important tests as to whether their torpedoes had the ability to break through the ice floes if the need arose. They first had to get the go-ahead from the Fleet, but they instead received orders to return immediately to Iokanga, a naval base and to be there by 20 July at the latest.

As the reactors reached maximum power one of the two turbogenerators quickly produced cracks at the level of the collector and the collector heated up to the point of catching fire. They quickly put all the power on one reactor and the technicians cleaned the collector with alcohol before starting the second reactor; this operation had to be repeated before they reached Iokanga.

They went through this avoidable risk all because Kruschev wanted to decorate them. (Petline, Giltsev and Timofeev getting the titles Heroes of the Soviet Union as well as the Order of Lenin and the Medal of the Star of Gold. The 10 combat and division unit heads got the Order of Lenin and the others got the Order of the Red Flag or the Red Star or got a Military Merit Medal).

As they had received the title "Hero of the Soviet Union" Peteline, Giltsov and Timofeev became overnight celebrities, but it was a full six months before the authorities told the Soviet people why.

Chapter 4 - The Nuclear Submarines Lost at Sea

The writer of the last chapters is Nicolaï Mormoul who for several years worked on the team investigating the accidents in his area. His reports showed too much independence and honesty and he found himself arrested and in prison for five years. After those years his fear of the system no longer exists - he is writing this to pay homage to all his comrades killed in the course of the accidents in the soviet nuclear submarine fleet, who almost all died through the carelessness and negligence of the authorities. Since the start of the 1950s the USSR has built 235 nuclear submarines (plus 300 diesel submarines), two cruisers with ballistic missiles and six nuclear ice-breakers. A number of the submarines have had accidents or sunk. At the time the book was written the CIS forces had 163 multiple mission submarines, of which 88 were nuclear and 59 other strategic submarines carrying ballistic missiles. Before starting on the soviet accidents, he first discusses those that took place in the US Navy.

A Submarine Named Hiroshima

Certain submarines have accidents in a never ending black chain and the K19 was one of them. Its bad luck started during construction, when a fire started in the hold, causing two people to be seriously injured. The following incident is the most serious of all its accidents and has until now remained secret.

As a general rule, the first start-up of the reactors of a nuclear submarine has to be done following strict guidelines. The commander, the second officer and the mechanical engineer must be in the command post and all the starting phases controlled strictly. On board the K19 though, this wasn't followed, the start-up was done by an ordinary team in the sole presence of the operators and the naval workers who had prepared the primary circuit without any inspection.

The operation consisted of progressively increasing the pressure in the loop and controlling the system with manometers. On the K19 though, these manometers hadn't been plugged in, so when the pressure was raised the machines still indicated zero. In the time it took to realise that something was wrong the pipes had had 400 atmospheres of pressure instead of the prescribed 200. This made the pipes expand, thinning the walls and altering the properties of the metal.

This usually demands a complete new loop with inspection boreholes in the pipes and replacement of the weakened parts. It also implies an inquiry to establish the guilt. All things considered, the commander decided not to inform his superiors. Shortly after, the lattice of the reactor became blocked. Instead of trying to sort it out, it was ignored and the lattice seized up in an intermediary phase. The repairs cost almost 10 million roubles. The mechanical engineer was sacked, but his replacement was to pay dearly for the irresponsibility of his predecessor.

At sea the K19 had as much misfortune - a sailor was crushed by the rudder at the bow, a petty officer had both his legs cut off by the lid of a launching tube and the submarine lost both its periscopes.

These could have been forgotten if it hadn't been for the drama on the 4 July 1961. On a mission in the North Atlantic the commander was informed that the pressure in the primary circuit pressurisers had begun to hiss violently - evidently the weakened pipes had burst. The commander knew that he should stop the mission to deal with this, but instead he continued. The inevitable happened, one of the reactors gave up. The alarms sounded in all the compartments obliging the crew to urgently compensate the residual heat which could damage the uranium fuel elements and produce a fatal increase in radioactivity. Instead of running the submarine aground so that rescuers could sort the situation out, the commander, Nicolaï Zateev, decided to see if the crew could sort it out, keeping the affair a secret.

As no emergency cooler existed to remove the decay heat, he decided to create a balance system to cool the reactors. The work meant that several men had to spend long periods in the reactor compartment exposed to active gases and vapours. The gas masks only worked for the first 40 minutes after which the only remaining protection for the men was to drink mouthfuls of 90% alcohol. A week later seven of the men died of radiation.

This patching up completed, the K19 continued on its way with only one reactor working and several contaminated compartments. Finally, the K19 approached two diesel submarines for help - the crew were evacuated and the submarine towed back to base. But from now on it was known as Hiroshima.

Even with a new commander on board and after all the repairs, the K19 was still fated. On the morning of the 24 February 1972 it succeeded in transmitting a short distress message to the headquarters of the North fleet saying how, after a fire whilst submerged, it had succeeded in surfacing, there were several victims and the vessel was no longer in working order. Shortly after its batteries gave up, so contact was lost.

Several hours later, in an extreme storm, a rescue mission set out, the boats involved being the Alexandre Nevski and the Mahomet Gadjiev. Knowing for how long the reactors had functioned they estimated their parameters. As the submarine wasn't in working order, they deduced that the complementary energy sources, batteries and diesel power systems, had broken down, were impossible to get to, or that there wasn't anybody to operate them. On the strength of these deductions they formulated the rescue operation. They also knew that the storm would delay the operation for a long time. The submariners watched them from the conning tower. Another patrol-boat arrived equipped with a helicopter which positioned itself above the submarine and dropped them an emergency parcel containing gas masks, warm clothes, torches, food and coffee.

After enormous efforts the men were evacuated from the submarine. A team of skilled first-aid workers and men skilled in radioactive detection managed to go on board and it was only then that the circumstances of the accident were discovered.

The morning of the 24 February, the 3rd team took the watch, the first two being asleep. The submarine was at a depth of 120M. At exactly 10.23 am the alarm siren went off as there was a fire in the 9th compartment. The 9th compartment was on three levels and housed the annex installations, kitchen and several cabins. It also had one of the three exit hatches on to the bridge.

The fire had been detected by a sailor visiting the kitchen who smelled burning. He went down to a lower level, to discover a carbon monoxide/ hydrogen burner on fire. The fire had been started by hydraulic oil pouring on white hot metal. The sailor recalled that several days earlier a hydraulic pipe had burst, spilling 500 litres of oil in the compartment. The mechanics had repaired the work, but obviously it hadn't been properly done or not all of the spilled oil had been wiped up.

Instead of sounding the alarm and fighting the fire, the sailor rushed to wake up the man in charge of the burner. First mistake.

The fire spread rapidly and the compartment quickly filled with combustion products at a time when the men weren't equipped with gas masks. The second error was the poor rescue operation organisation. Several sailors lost consciousness, asphyxiated by the carbon monoxide. Three weeks after the fire, the concentration of this was still raised to 32 mg/litre, the dose limit being 0.005 Mg/litre. Under the effect of the flames, the principal air duct exploded, throwing a powerful stream of oxygen into the fire. The fire could then be heard in the neighbouring compartment, where the command post and reactors were.

When the door between the 8th and 9th compartments was opened to let the men out of the 9th, a cloud of toxic smoke followed them. The commander ordered all the men, except those whose work consisted of maintaining the vital functions of the vessel, out of the stern compartments, saving more than one life.

Between times the submarine tried to surface. It was at a considerable depth and only the proper functioning of the reactors would ensure a surfacing without damage. Unfortunately, the 8th compartment, that which fed the reactors with electricity, was already overrun with flames and a stream of compressed air carrying combustion products. The electricians died without leaving their machines.

The carbon monoxide infiltrated as far as the manoeuvring room, threatening instant death to all those in the compartment. Conscious of the danger Victor Milovanov, head of the propulsion division, ordered his subordinates to leave the desk. Victor Milovanov shut down both reactors. The turbine operators in the 7th compartment also stayed at their posts to ensure the safe emergence of the submarine, this too filled with poisonous fumes and some of these men also died.

In total blackness, several men, carrying bulky diving suits, tried to get the power systems in the 5th compartment going, as with the reactors off it was vital to find another power supply. They tried in vain to get the diesel generator going.

Further, on leaving the 5th compartment, the emergency group couldn't completely close the air intake valve and almost 200 tonnes of water rushed into the compartment drowning the power systems, the principal air conditioning system ventilators and the remote control machines for the reactors.

They finally surfaced and two men tried to reach the 8th compartment to inspect the wall separating the block on fire. The compartments were so blackened by smoke that the rays of the torches didn't even light up a metre. Opening the door of the 8th compartment all they could see were corpses, they couldn't get to the 9th, yet they had to because 12 sailors were still in there.

The Prisoners in the 10th Compartment

The 10th compartment of submarines of this type housed 12 men, two torpedo tubes and a comfortable reserve of ammunition. It had a volume of 139m^3 and was so riddled with equipment that there was only a narrow passage between the bunks.

When the alarm sounded on the 24 February 1972, these men got up and sealed their compartment, isolating them from the rest of the submarine. They knew that the fire was in the 9th compartment as the wall between them became hotter and hotter. They tried to contact the central post, but nobody replied and the emergency phone wasn't working either.

Within a quarter of an hour some of the men had fallen over, evidently the ventilation system wasn't sealed and carbon monoxide had got into the compartment. The valves were rapidly tightened. Shortly after, they found themselves in complete blackness as the lights went out.

They knew the moment the submarine surfaced and that there was a violent storm going on as the submarine tossed in the waves.

By the end of the first evening they made contact with the commander of the first compartment on the emergency phone, who told them the situation of the vesel and forbade them to even try leaving their compartment, as just one gulp of the air in the 9th compartment would signify certain death.

The rescue team managed to supply them with air, but this was still so precious that those carrying out no work had to lie down, so consuming the least amount of air possible.

Luckily the 10th compartment contained a tank of water, but as always at the end of a cruise it was empty. Each tank though had a "dead" reserve, a quantity of water which stagnates in the bottom of the tank. This wouldn't last them long though, so they had to think again. Submarines sweat a lot and on board it was around 22°C when it was -4°C outside. It turned out to be sufficient to wipe all the surfaces down with rags and wring them out into a bowl. There was so much it was no longer necessary to ration water.

The emergency food supply though had to be strictly rationed as people had been helping themselves to it throughout the trip.

The wall that separated them from the 9th compartment became so hot it bubbled. Thanks to a valve they drew sea water and poured it over the wall to try and cool it down.

By the 5th day their air supply had worsened, the air in the first compartment was so contaminated that carbon monoxide had forced its way into their supply duct. Luckily for them the rescue crew arrived the following day and re-established their air supply. They could also hear the helicopters above.

For the rescue crews it was necessary to urgently ventilate the submarine and install an electricity supply, but boats couldn't approach the K19 as the slightest collision would cause it to sink. They eventually set up an outside electricity supply.

By the 18th March the only obstacle stopping the evacuation of the prisoners was the 9th compartment, where the carbon monoxide was still at a concentration of over 3 Mg/litre. Nevertheless they had to start the rescue operation.

Wearing breathing apparatus a crew went into the 9th compartment - there was devastation and roasted corpses everywhere. The prisoners in the 10th heard the noise they made and the sounds of joy were plainly heard.

The watertight door between the two compartments was soldered to with the heat but opened after the air pressure in the 10th was increased.

The prisoners were quickly given gas masks and their eyes were bandaged up, unused to light for almost a month. A few minutes later they were once more in the fresh air.

The drama cost the lives of 30 sailors - 28 had been killed by the fire, the cipherer of the Alexandre Nevski had been swept out to sea and an officer on the Mahomet Gadjiev had been fatally wounded. It took 20 years for the circumstances of the K19 catastrophe to be known.

<u>The Shipwreck of the Best Vessel of Its Time</u>

Five months after Chernobyl, on the 3 October 1986, a fire broke out in a compartment of a Soviet nuclear submarine armed with ballistic missiles, it was around 1000 KM north-east of the Bermudas.

On the 6 October at 11.03am the submarine sank to a great depth, the crew already having been evacuated.

Early in the morning of the 3 October as the K219, "Yankee" in Western terminology, changed depth, water started coming on board for an unknown reason through the 3rd portside missile tube . The force of the liquid was such that it crushed the casing of a missile, immediately causing an explosion in the 4th compartment. The solidity of the hull stopped the submarine from sinking and the impact of the explosion took place on the lid of a launching tube which pulled itself out. Fire broke out. The liquid fuel, which burnt, released vapours and at the same time the water rushed into the opening of the tube, continuing to force its way into the submarine even after it surfaced.

Once at the surface, the crew set the 2nd reactor working and located the fire. Unfortunately, the combustion had produced leaks of motor fuel. At places the concentration of this toxic gas passed the normal limit by 3 thousand times, so the men found themselves separated, some at the stern, some at the bow.

After a 15 hour struggle for the survival of the vessel, the situation became catastrophic. The water produced a short-circuit, which in its turn scrammed the starboard reactor. The people watching on the command desk saw that 4 shim lattices (safety rods?) hadn't reached the lowest level required to guarantee the complete shutdown of the reactors. It also proved to be true that the remote control system of the reactors was broken, so the two reactors risked restarting - threatening a huge radioactive contamination zone. The only way the shim lattices (safety rods?) could be lowered was by hand.

It was necessary to locate where the crank handle was placed and turn it. In the stern there were two experienced reactor technicians - lieutenant-chief Nicolaï Belikov and sailor Sergueï Preminine, so everything rested on their shoulders.

Belikov in a protection suit entered first and finally managed to break open the lock on the tool box. He fixed the crank-handle on to the pivot and began turning. Just as he stopped the first lattice (rod?) he became violently dizzy and managed to stagger back to the 8th compartment.

By the time he had come round they had already kitted Sergueï Preminine out in a protection suit. The two of them went down into the reactor compartment. They stopped both the second and third lattices (safety rods?) before being overcome by the heat and fumes. The two men reappeared in the 8th compartment looking like puppets. It was clear Nicolaï Belikov would be unable to return into the 7th.

Preminine returned alone, but since he and Belikov had left, the situation had become more aggravated - the temperature reached 80°C and the pressure rose spectacularly. Normally the shim lattice (safety rod?) can be lowered in 20 seconds, but it took him more than half an hour. Just as he was reaching his time limit, with the gas mask, he completed the task. He then found he could not get out of the reactor compartment, the fire had wrecked the compressed air system, giving a rise in pressure 400 Kg/cm^2 in all the living compartments. All the sailors experienced was a slight buzzing in their ears, but it was sufficient to block the two trap doors in the reactor compartment.

They tried to equalise the pressure in the two compartments, but as they did so, thick toxic smoke forced its way into their block. The commander ordered Serguei to open the ventilation system, but he was too weak to do so. Some of his comrades tried to break the door down, but it was in vain and eventually they had to evacuate the compartment due to the fumes. They were evacuated shortly after from the submarine on to Soviet vessels and at 11.03 am the submarine sank, the body of Serguei Preminine still on board.

The Drama on Board the K3

The drama took placed on the 8 September 1967, in the course of a mission carried out by the second crew. A fire surged through the bow compartments killing 39 people.

It started when a hydraulic pipe burst, throwing a jet of boiling oil into the compartment. At that time the loops were filled with inflammable aviation fuel. A short-circuit happened in a lampstand and several instants later there was a fire.

The jet of oil on fire broke up the metal wall and quickly burnt to death those men in the 1st compartment, as well as those in the portside part of the second block. Those in the starboard side were asphyxiated by carbon monoxide.

The Price of Carelessness

A classic example of this is shown by the K429. On the 24 June 1983 it went out into the Bay of Kracheninnikov to carry out a commonplace balancing operation. Nothing more routine, if it hadn't been for the fact that the K429 had a negative floatability. In fact, it was too heavy by 60 tonnes and the sailors whose job it was to inspect the weight just ignored it.

The inevitable happened. Whilst filling the middle ballast tanks, instead of staying on the surface, the submarine took a leap down and reached the bottom at 35M. Coupled with this, the depth gauges indicated zero as they hadn't been plugged in. As the submarine wasn't supposed to dive, all the air outlets had remained open and now water was travelling through the ventilation system. The alarm sounded and the commander gave the order to blow the principal ballast tanks, which would allow surfacing.

In the panic the operator at the command post made a key mistake, the consequence of which was that far from expelling the liquid accumulated between the two hulls, the compressed air bubbled without moving the submarine an inch. The only result was that millions of bubbles rose to the surface, showing the location of the K429.

During these superfluous manoeuvres, the reserves of compressed air fell by 70%. The remaining 30% wasn't enough for the submarine to surface. The submarine was also at an angle of 15° which stopped the release of the radiophonic and acoustic buoys. It also made it impossible to use the emergency catapult room, capable of shooting four men to the surface.

In certain compartments the pressure became enormous and the temperature rose to 50°C. The sailors also discovered that no life-jackets had been put on board and that they only had 50 diving suits, but 106 people. On the 25 June, the two batteries giving the electricity exploded.

The following day two of the experienced submariners decided to leave the submarine themselves, going out through the torpedo tube of the 1st compartment. They were picked up by a patrol boat and taken to base.

The rescue operation took 44 hours, but two men died diving and it was several months before the submarine was refloated.

Chapter 5 - The Shipwreck of the Komsomolets: Chronicle of a foretold tragedy

The K278, official name Komsomolets, was put in service in 1983 - its originality being the titanium hull which allowed it to go to a depth of 1000 M.

Six years later, on the 7 April 1989, in Norwegian waters, on the way back to base it suffered a terrible accident and finally sank.

At 11 am, whilst the rest of the crew were eating, the watch officer gathered his reports from the various compartments. All was fine. Three minutes later, at 11.03 am, the alarm sounded and the man at the command desk shouted that the temperature in the 7th compartment was over 70°C. It sounded like a fire.

They kept trying to make contact with the watch sailor in the 7th with no success. It was evident that he was dead, so they tried to put the fire out with freon.

It would have succeded, but an electric arc cut a compressed air pipe, the air was to fill the principal ballast tanks. The compartment immediately turned into a furnace.

Several seconds later, a jet of fire forced its way into the 6th compartment.

The crew stopped the starboard turbogenerator and that on the portside stopped itself. The shutdown of the reactor was set in motion and the submarine stopped itself. What followed was a chain of accidents that seemed to be without end.

It was suddenly noted that the water cooling pump showed signs of weakness and was sputtering dangerously. A little later the vertical rudder jammed and the telephone connection between the compartments was cut.

With 1000 M of water below and 150 M above, the submarine was in an immobile state, stuck between two bodies of water. The fire raged in three compartments, but it was impossible to send freon into the 5th and 6th compartments as there were still men in them.

Certain systems were cut so that branches of the reserve installations could be plugged in. The reactors were stopped. Gently the K278 started to resurface, but with the rudder jammed, the submarine approached the surface in uncontrollable spirals. At 11.14 am the submarine finally surfaced, but the fire still raged in the rear compartments.

At 11.27 am there was gas contamination and lowering of visibility in the command post. An air analysis was carried out, showing that the concentration of carbon dioxide there was fatal, so it had to be evacuated, bar those needed for fighting the fire.

At 11.45 am it gave out three distress signals, but got no reply of anyone having received them.

At 11.58 am they had no connection with the 4th compartment, there were 9 people there. Two volunteers were sent down and found two men.

12.10. After having transmitted 8 distress signals, they still had no reply. It was only at 12.25 that the base received an SOS and the first connection between the two wasn't until 13.27.

After ventilating the 4th compartment, the two volunteers moved on to the 5th. The sight which greeted them was like a horror film: the men were still alive, but burnt atrociously. The skin on their arms hung in shreds, the rubber mask of a lieutenant had melted on to his face. They were immediately evacuated to the bridge where the doctor did what he could for them.

The two volunteers tried to get into the penultimate compartment, the 6th. The wall was glowing and at a temperature of over 100°C. On opening the door they were met by a thick cloud of black smoke, it was obvious the fire was still burning.

At 14.18 they finally established radio contact with a plane and it gave them the message that a rescue boat would be with them at about 18.00. The Norwegian vessels in the vicinity were never contacted.

At 16.24 the hull of the submarine shook due to internal explosions. Apparently the regeneration boxes (to absorb the CO_2 gas produced by the crews breathing) exploded one by one. In several minutes the titanium hull opened and the water rushed into the two stern compartments. The rear of the K278 sank in the waves in several seconds. The commander immediately ordered the men to leave.

The bridge sloped so much it was impossible to stay on it and the men went into the icy waves. The life rafts were sent off, but didn't inflate, so just sank.

At 17.08 the Komsomolets disappeared in the waves, taking six people with it, only one of whom survived. They used the emergency room, but only one had managed to put the equipment on properly by the time they reached the surface, which is why the others died.

At 18.20, 30 men were rescued but three of them died before reaching Severomorsk. Of 69 crew members only 27 survived.

At the time there was no radiation in the sea, but as time progresses and corrosion sets in it would become a problem, so thoughts turned to refloating the submarine.

Since the end of the war, three Soviet war navy submarines, one of which was nuclear, have been refloated. They were:

- the S80, a diesel submarine of the North Fleet, refloated in 1969 in the Barents sea. It was at a depth of around 200M. It had sunk with 68 crew men on 27 January 1961.

- The K429, whose story was told in the last chapter, was brought up in 1986.

- The K129, a diesel ballistic missile submarine, which sank the 8 March 1968 in the Pacific. Like the Komsomolets it sank to a great depth of 5000M, but was refloated by the USA.

  It set sail on 24 February 1968 and suddenly disappeared with more than 100 men on board. The soviet search operation lasted more than three months without result. The inquiry commission just concluded that it disappeared - end of story. Not so for the rest of the world.

  It had had an explosion whilst submerged, started by the destruction of the hull, which the US Navy had detected. One of the possible causes of its shipwrecking was a collision with an American submarine. If this was the case, the Americans couldn't just 'ignore' the shipwreck. They knew the co-ordinates at which it had sunk, so, ensuring the soviet services had abandoned the search, the USA and CIA launched a refloating project which took over six years to complete.

  The actual process started in May 1974. On arriving at the surface the submarine broke up and was eventually retrieved in five pieces.

The refloating of the K129 proved that it was technically possible to refloat the Komsomolets, but it needed to be retrieved in one piece and the USSR and the Western countries didn't have the technology to do that, so it is still there.

Nicolaï Mormoul discovered that in 30 years there had been 144 serious accidents on board nuclear submarines in the North Fleet alone, without counting the breakdowns, of which the majority were never reported.

Out of 6 of the shipwrecked soviet submarines lost at sea, three of these, the K8 in 1970, K219 in 1986 and K278 in 1989, followed an identical pattern which can be broken into six phases:

1. Fire whilst submerged during a patrol operation, generally at the end of the cruise on the way home.

2. Surfacing of the submarine and a struggle for survival. The vessel finds itself without movement or contact.

3. Problems of contact with the central post, which don't know the situation in all the other compartments.

4. Leaks into the pressure hull.

5. Loss of buoyancy and stability.

6. The submarine disappeared.

He also arrived at a conclusion of the common causes of accidents on board nuclear submarines:

1. At the conception, creation and construction stage

   - technological delays in certain areas such as computing, detection devices and sound-proofing.

   - conception faults due to there being several constructors on the same project.

2. At the production stage:

   - non-observation of technological disciplines and criteria imposed by the constructor.

   - bad quality of work because of overestimated plans or working in jerks.

3. At the trial stage:

   - failure to undertake planned tests and trials, to late deliveries or late assembly work.

   - the checking and signing for systems which were known to be defective.

4. At the operational stage:

   - deficiency of infrastructure for reporting and repairing.

   - breaches of operating and maintenance instructions through negligence.

   - finally, under-equipment of the rescue services and bad co-ordination of search operations principally at international level.

After all the trouble with the Komsomolets there are still accidents going on, the first was only three months after the Komsomolets, on 26 June 1989. It took place in the Norwegian sea and there were no victims. Finally, in October 1991, a ballistic missile exploded in its tube on board a Typhoon. It was due to a construction fault that was known about, but about which no-one had done anything. There were no victims and the repair work will take three years.

Chapter 6 - Waste Disposal Techniques

As with all nuclear powers, in the last 30 years the Soviets have accumulated mountains of radioactive residues, millions of tonnes of solid fuel and tens of millions of spent fuel cartridges. The first Soviet waste appearing at the end of the 1940s.

Radioactive waste of codename "Maiak" (Phare) was managed with unconcern - it was simply dumped in the Tetcha River. The inhabitants of this region use this water to bathe in, water the garden with and as drinking water for their livestock. 124,000 people were irradiated, 28,000 received the biological equivalent of 170 roentgens when the maximum dose should only be 100.

In 1957 a storage facility filled with radioactive waste exploded contaminating an area of 23,000 km², in the regions of Tcheliabinsk, Tioumen and Svedrlovsk populated by 270,000.

In order to get the fullness of the "Maiak" disaster it's enough to quote several figures: 450,000 irradiated people in the Tcheliabinsk region alone, 138 million curies on the ground against 50 million at Chernobyl. 500,000 tonnes of solid radioactive waste have been buried. 2½ Chernobyls have been dumped in Lake Karatchaï and almost 20 Chernobyls are still contained in similar storage facilities to that which exploded in 1957. 500 million metres cubed of radioactive water are kept in artificial ponds hollowed out in Tetcha. The level of radioactivity by these expanses of water are today raised to 1500 microroentgens an hour.

Nowhere in the world though is as saturated with nuclear waste as the Kara sea. Tens of millions of spent fuel cartridges are stocked on the Kola peninsula alone. Radioactive leaks in that sea have been enough to kill millions of sea animals in the neighbouring sea - the White Sea.

USSR military regulations formally forbid the burial at sea of waste containing nuclear fuel, control rods, ionisation chambers and ion exchange resins. Exceptions are tolerated though.

The main lie is the claim that no such burials have ever been carried out. A map does exist though showing where, from 1964 to 1986, waste, including submarines, has been sunk.

The waste containers are made watertight, but if the containers refuse to sink, they are simply shot at with a machine gun, so that they fill with water and sink like stones.

The other technique used to get rid of waste is to stock it on board old warships until they are full. Then the vessels are towed out to sea and sunk. In 1979 though the captain of the towboat, pulling a barge loaded with solid radioactive waste, decided he wanted to lose the barge so simply untied the tow rope. The co-ordinates of the spot were never noted.

It is frightening to compare the recommendations of the International Agency of Nuclear Energy with those done by the USSR. In one case over 100 assembly cartridges were enclosed in a single container, exceeding the recommended radioactivity norm several hundred times. It recommends a minimum sea depth of 4000 M for the sinking of radioactive waste, in the USSR they sank waste anywhere between 18M and 370M. 18M, but more depth close to the mainland, the habitated archipelago of Novoia Zemia and frequently used maritime paths.

The inhabitants of Murmansk are now very concerned about the dangers of the waste and are demanding an investigation in their waters to be carried out by a scientific body not related to any Ministerial bodies.

After several years of operation, the radiological situation on board several submarines became so bad that the only solution was to remove the reactor compartment and all its equipment and completely replace it. In the mid 1960s this was done 4 times - it was planned on the K3 and K5, but followed an accident on the K11 and K19.

On the K3 and K5 the fuel was completely taken out and then the two reactors were filled with a solidifying mixture. On the other two submarines it was impossible as the fuel cartridges had been broken in the course of work. In the end they were filled with a solidifying mixture. The submarines were then towed out to sea and sunk. Eight reactors were sunk in this manner, in the bay of Abrassimov.

In the 1960s when liquid metal was used as a cooling fluid, the Americans spotted its disadvantages as well as its advantages and stopped using it, the Soviets saw the problems but didn't stop its use. The first Soviet submarine using a liquid metal coolant was put into operation in 1963 under the code name K27.

On the 24 May 1968 it had an accident, the environmental effects of which are catastrophic. Whilst on a mission in the Mediterranean the indicators suddenly showed something was wrong and several seconds later the power of the portside reactor fell to 7% of its maximum level. No matter what was tried they couldn't get the level to rise.

Following a leak, the reactor started to overheat, bringing about the destruction of 20% of the fuel cartridges. The gamma activity in the compartment shot up like an arrow. It reached more than 2000 roentgens in the reactor block and in part of the central post. It was immediately followed by a jet of radioactive gas which spread to the other compartments. Although the radiation was massive inside, it was normal on the outside of the hull. All 124 crewmen got overdoses of radiation.

The research work on how to save the submarine took over 13 years. When it was finally retired from experimental use in December 1973, the problem then was how to bury it. This wasn't finally completed until 1981.

They decided to sink it, but in the case of intermediate reactors, one glass of water alone is enough to start a reaction. The technicians unanimously stated though that the core had been constructed in such a way that any reaction would stop itself in a short time. It was therefore decided it would be safe to sink it.

The active zone of the reactors was filled with a lead-bismuth alloy. After which fourourol (a type of concrete?) was injected into the empty spaces of the reactor. The rest of the compartment was then covered in bitumen.

It was finally sunk on the 6 September 1981, about 300M from the coast, and at a depth of about 33M. Nobody carried out any research as to how long the sarcophagus would withstand the action of the sea water before it was sunk.

Even if one day the K27 doesn't shake the planet by a nuclear explosion, the leaks could be enough to spread through all the seas and oceans.

The big question now is what will the ex-USSR do about all the nuclear submarines just about to finish their service?

Postscript

Discusses how to reduce nuclear waste and so reduce risk to the environment and risk to human life.

Notes on Maps and Illustrations

Chapter 6 - Map of the Biggest Naval Nuclear Cemetary in the World in the Novoïa Zemlia Archipelago

Solid radioactive waste sunk at open sea.

1. Novaïa Zemlia depression: 1450 containers, a barge loaded with a broken nuclear reactor, a tanker filled with liquid waste.

2. Bay of Neoupokoïev: radioactive waste totalling 3400.

3. Bay of Tsivolka: 4750 containers, cargo boat Nicolaï Baumam and central compartment of the Lenin ice-breaker with its three reactors at a standstill.

4. Bay of Oga: 870 containers.

5. Bay of Stepovoï: 1850 containers and a submarine, K27 with its two piles still loaded with fuel.

6. Bay of Abrassimov: 550 containers and the propeller compartments of 4 submarines (eight piles, of which three are still loaded with fuel).

7. Bay of Bien-Etre/well-being?: 650 containers.

8. Bay of Courants: a reactor without fuel (1850 curies).

9. In the vicinity: 400 containers.

10. In the vicinity: 250 containers.

Site of Nuclear Trials:

11. Cape of Soukhoï Noss: strongest atmospheric tests, sanitary zone.

12. Matotchkine Char straits: last underground mine tests, sanitary zone.

13. Black Bay: site of the first ground and mine submarine trials at Novaïa Zemlia, place foreseen for the burial of the Komsomolets (if it's refloated), sanitary zone.

14. Place chosen for a regional nuclear cemetery.

15. Place foreseen for the programme of long-term nuclear trials.

Ch3 - Map of the Polar Route Taken by the K3

The polar route taken by the K3 in July 1962. For the first time the Soviets reached the pole under the ice. The Roman numerals indicate the places where the submarine emerged.

I 85° latitude to check that they could go on with the mission.

II The first clearing they found in the ice big enough for them to surface in after having reched the North Pole.

III The site where the torpedo tests should have taken place.

Ch4 Nuclear Submarines lost at sea

Map of the sites where 7 Soviet and 2 American nuclear submarines, carriers of nuclear arms were lost at sea between 1963 and 1989.

1. Thresher (10 April 1963), American submarine SSN-593 sunk 100 miles east of Cape Cod rests at 2590M.

2. Scorpion (between the 21st and 27th May 1968), American submarine SSN-589 lost 400 miles south-west of the Azores rests at a depth of more than 3000M.

3. Soviet submarine (11th April 1968) lost with 5 nuclear arms, 750 miles north-west of Hawaii.

4. Soviet submarine (1968) lost in the north-east Atlantic with 4 nuclear arms.

5. Soviet submarine (12th April 1970) disappeared off the Brittany coast, rests at 4600M.

6. Soviet submarine (12th April 1970) lost in the north-east Atlantic with 4 nuclear arms.

7. Soviet submarine (June 1983) lost at Kamtchatka with 8 nuclear arms.

8. Soviet submarine (4th October 1986) equipped with Nuclear arms sunk 1000 KM north east of the Bermudas, rests at 5000M.

9. Komsomolets (7th April 1989), soviet submarine with nuclear arms, sunk following a fire on board, near the Norwegian coast, 180 KM south-west of the island of Medvezhy.

LIST OF SERIOUS ACCIDENTS IN THE SOVIET SUBMARINE FLEET

No.	Date	Submarine	Commander	Number of Victims	Place and circumstances of the accident
1.	13.10.60	K8 North Fleet	V Choumakov	13 irradiated	Breakdown of a steam generator during an exercise at sea
2.	04.07.61	K19 Hotel Hiroshima North Fleet	N Zateiev	7 dead	Breakdown of a reactor whilst on patrol (Ch 4)
3.	12.02.65	K11 November North Fleet	U Kalachnikov	A group of staff irradiated	Uncontrolled start of a reactor whilst reloading due to staff negligence
4.	20.11.65	K74 Echo I North Fleet	A Agapov	No victims	Destruction of the starboard turbine following a breakdown of an automatic appliance
5.	08.09.67	K3 November North Fleet	U Stepanov	39 Dead	Fire in the 1st and 2nd compartment whilst on patrol (Ch 4)
6.	08.03.68	K129 Gulf Pacific Fleet	V Kobzar	Almost 100 dead	The submarine sank during a patrol mission off the island of Guam. Refloated by the Americans in May 1974 (Ch 5)
7.	24.05.68	K27 (liquid metal) North Fleet	P Leonov	5 dead, 12 seriously irradiated	Breakdown of a reactor whilst at sea (Ch 6)
8.	10.10.68	K26 Yankee I North Fleet	A Boubnov	1 dead	Bad ventilation system near a battery

LIST OF SERIOUS ACCIDENTS IN THE SOVIET SUBMARINE FLEET

(Continued)

No.	Date	Submarine	Commander	Number of Victims	Place and circumstances of the accident
9.	23.08.68	K140 Yankee II North Fleet	A Matveiev	No victims	Uncontrolled start of a reactor
10.	10.04.68	K172 Echo II North Fleet	N Chachkov	Intoxication of staff	Intoxication of all the compartments by Mercury vapours during a patrol in the Mediterranean
11.	11.04.70	K8 November North Fleet	V Bessonov	52 dead	Fire during a patrol mission in the Biscay Gulf. Sank to a depth of 4680M
12.	23.09.72	K19 Hotel North Fleet	V Koulibaba	28 dead	Fire during a patrol in the North Atlantic (Ch 4)
13.	06.04.74	K420 Yankee I North Fleet		No victims	Fire in the 10th compartment
14.	28.06.75	K447 Delta I North Fleet		2 injured	Explosion of a battery at the quay
15.	07.12.75	K36 Echo II North Fleet		2 injured	Explosion of a battery
16.	10.09.77	K403 Yankee I Pacific Fleet		Several injured	Explosion of a battery whilst submerged
17.	02.09.78	K451 Yankee I Pacific Fleet		No victims	Fire in the turbo-generator block
18.	28.12.78	K171 Delta Pacific Fleet	E Lomov	3 dead	Breakdown of a reactor and inadequate crew

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LIST OF SERIOUS ACCIDENTS IN THE SOVIET SUBMARINE FLEET

(Continued)

No.	Date	Submarine	Commander	Number of Victims	Place and circumstances of the accident
19.	30.11.80	K222 North Fleet	Y Goloubkov?	No victims	Uncontrolled start of a reactor, destruction of the primary circuit
20.	08.04.82	K123 Alpha North Fleet		No victims	Destruction of the primary circuit. Repairs lasted 9 years
21.	24.06.83	K429 Charlie II Pacific Fleet		2 dead	Sunk in the bay of Kracheninnikov during a balancing operation (Ch 4)
22.	18.06.84	Echo I	E Selivanov	13 dead	Fire during a patrol
23.	06.10.86	K219 Yankee I North Fleet	I Britanov	4 dead	Explosion in a launching tube. Fire. Sank off the Bermudas to a depth of almost 5000M (Ch 4)
24.	01.04.89	K278 Komsomolets	E Vanine	42 dead	Fire during a patrol in the Norwegian Sea (Ch 5)