Chapter 3. Environmental risks when extracting and exporting oil and gas.

This chapter presents the environmental risks connected with conducting oil and gas activities in Northwest Russia. The chapter raises the question of environmental risks when exploring, developing and transporting oil and gas on the Arctic shelf. The emissions by the industry are described, and the chapter also includes a section on the concentration of petroleum products in the Pechora, Barents and White Sea. Some statistical data relating to accidents caused by oil spills or gas leaks during transport are also presented. For further information about petroleum accidents in the Arctic, we recommend chapter 4 of this report *Oil and gas accidents and incidents – prevention and liquidation*.

A substantial part of the research referred to is taken by "Sevmorgeo", a Federal State unitary scientific and production enterprise. The data on the content of petroleum products in the waters of the Pechora, Barents and White Seas are also from the "Sevmorgeo" enterprise.

For further reading we recommend the appendixes of this chapter; III-I *Climate Change, and III-ii The Greenhouse Effect*, together with chapter 5 *Environmental impact of oil and gas activity in the Arctic.* We also recommend as complementary reading appendix IV-i *Consequences of a large oil spill in the Arctic,*

All the information presented in this chapter is accompanied by reference data, opinions from specialists, legal notes and illustrations.

3. 1 Environmental risk when carrying out geological surveys

The impact on marine organisms and ecosystems already begins with the geological and geophysical investigations of the seabed, where the objective is to determine its oil and gas-bearing capabilities. Offshore seismic surveying is based on the generation of seismic waves which are reflected off the bottom of the sea. This allows an opinion to be formed on the structure and oil and gas-bearing capabilities of the sedimentary rocks.

Here's a thought...

Seismic activity has been conducted by the petroleum industry since the 1950's. At that time explosives were used to map the seabed, which seriously harmed marine life. Since the 1970's air canons have been used. Research shows that seismic activity harms fish eggs and larvae in close proximity to the air canon. How seriously seismic activity affects fish is under discussion. However, there is no doubt that fish within a 2-3 kilometre radius from the ships are being affected. Both fish migration routes and reproduction are disturbed. The Norwegian Ministry of Oil and Energy reports that seismic activity in Norway is regulated based on research and limited so as to avoid seismic activity in breeding periods and in the vicinity of important fisheries.

When conducting seismic surveys the hydraulic impact of up to 150 atmospheres results in the destruction or damage of organs and tissues of fish. There are known occurrences of the disruptions in migration routes of salmon in the area of seismic surveys.

Furthermore, the noises created by seismic prospecting interfere with marine organisms' ability to determine other sounds, communicate with each other and search for food. In particular, this concerns whales. There are instances where animals, attracted by unknown sounds, received serious and lethal wounds from powerful hydrostrikes.

Many species of fish leave areas of seismic prospecting permanently. They will be followed by predators leaving their favorite habitat. However, some organisms can only live in strictly determined conditions, and many of them die when they are unable to adapt to a new environment.

3.2. Environmental risks when exploiting oil and gas

Large-scale offshore projects concerned with oil and gas production releases a large quantity of emissions into the atmosphere, the marine environment and so forth. The environmental consequences remain for a long time after oil and gas production on the field has ceased.

3.2.1 Emissions to sea

Here's a thought...

"Activities undertaken by oil companies are directed at the intensive extraction of oil with minimum investment. The lack of economic stimulus and state control leads to selective extraction of the most productive reserves, a reduction in the oil recovery coefficient and the irrevocable loss of part of the oil reserves. In Russia, on average, the recovery ratio is 35% which results in the need to develop new fields and, consequently, an increase in ecological loads on the environment", suggests Nina Lesikhina, co-ordinator of energy projects organised by the "Bellona-Murmansk" regional public organisation.

When a seismic survey points to the presence of oil and gas structures the drilling of wells usually starts. Almost all the stages and operations involved in surveying and extracting petroleum entail liquid and solid waste. These volumes of waste may be as high as 5000 m^3 for every well sunk. This waste constitutes geological material in the form of spent drilling fluids and sludge drilled out from the well. The liquid waste consists of toxic impurities needed for the co-ordinated working of the drilling equipment, heavy metals which accumulate as a result of working the geological material, and also clay suspensions which increase the turbidity of the water in discharge areas. The use of drilling fluids with a petroleum base is very harmful for the environment. Mud which is saturated with this fluid is the main source of oil contamination during drilling work.

Here's a thought…

According to estimates of environmental risk posed by oil spills in the Barents Sea, which were carried out by the scientific research centre "Informatika riska", the sum total of possible influences of individual projects exposes water expanses of up to 100,000 km^2 and coastline in excess of 4,000 km to the risk of pollution.[1]

Another significant source of contamination is the discharge of so-called produced water originating from wells. Its composition is not just characterised by a high content of petroleum hydrocarbons and heavy metals, but also by abnormal mineralisation, which is usually higher than the salt content of seawater. This may be a cause of the disruption of the hydrogeochemical characteristics in the area where stratal water is discharged. Furthermore, this produced water contains natural radionuclides which separate out into the sediment and form local micro accumulations upon contact with the seawater. When an oil field gets older, the emissions of produced water will rice heavily, and from old oil fields the amount of produced water can be bigger than the amount of produced oil. The water can either be let out in the sea, as it is or cleaned before discharged back to the sea, or it can be injected back into the reservoir.

For your information:

The Norwegian company AGR has developed Riserless Mud Recovery (RMR) technology. This is an advanced technology which cleans all mud and waste from the top hole when drilling wells. The technology is in use in many parts of the world, especially in vulnerable areas such as the Great Barrier Reef in Australia. Surprisingly, this technology is not required when drilling in the Norwegian part of the Barents Sea.

According to the Russian law, spent drilling fluid and other waste products from drilling should be collected and transported to shore for subsequent treatment, or undergo special purification prior to disposal overboard. Frequently, these precautionary measures are ignored. At present, there is a lack of efficient technology available for treating petroleum products as well as a lack of specialised overflow reservoirs.

The impact of waste from one particular well locally may be felt over a radius of 3-5 km. However, if the number of wells is sufficiently great, their negative influence may envelope the entire fishing industry in that area. For example, the poor condition of the ecosystem in the North Sea is partially due to petroleum activity, concludes a report from the Norwegian Institute of Marine Research. [2]

Here's a thought...

"At present, no available technologies guarantee 100% purification of the produced water which would entirely preclude hazardous substances from entering the marine environment. There is also a problem associated with the fact that the older the field, the greater the volumes of the produced water and the less the quantity of extracted oil. Hence, for instance, in the Tampen area of the North Sea, the quantity of produced water exceeds the quantity of oil twofold", according to Unne Berge, a specialist from the Bellona Foundation.

Here's a thought...

Hydro was given permission to test drill in the Norwegian Barents Sea in 2004. The Norwegian Institute of Marine Research protested to the test drill in their public comment on principle because Hydro was given permission to discharge 266 tons of different chemicals to the sea. The Institute argued that it had insufficient information about the content of the chemicals and the kind of testing the different chemicals had been subjected to . The producers did not give away this information because they considered this a product secret.

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[1] *"The shelf does not need oil spills" - "Neftegazovaya vertikal" journal, January 2006.*

[2] *The resources of the Sea and its environment 2007*, Norwegian Institute of Marine Research.

3.2.2. Oil spills.

Oil-and gas development will also lead to spills of oil or chemicals that are not planned. Internationally most of the accidental spills are of course smaller oil spill. The most frequent causes of accidents are equipment failure, errors committed by staff and extreme environmental conditions. The environmental consequences of accidental discharges are especially severe when they occur near to shore, or in remote areas.

> **For your information:**
>
> **OSPAR** - The Convention for the Protection of the Marine Environment of the northeast Atlantic. 15 European countries are signatory states. OSPAR monitors ecologically harmful substances and radionuclides in marine waters.

The worst case scenario is a big uncontrolled blowout; this is an uncontrolled release of oil or gas during drilling or production. Oil or gas begins to flow into the wellbore and up the annulus and/or inside the drill pipe. If this situation escalates, the outcome is a blowout and oil and gas will reach the surface. Blowouts can cause huge damage to drilling rigs and injuries to rig personnel, as well as being an environmental disaster.

The next group of accidents follows regular "normal" discharges that could be stopped for some hours without extra equipment. The danger of these emissions resides in their regularity, which in the end leads to chronic pollution of the marine environment.

One-off, or systematic oil spills, may seriously impair the functioning of the marine ecosystem by: deterioration in the chemical composition of the water and its physical characteristics (transparency, temperature and so on), deaths of living organisms as a result of oil products penetrating the surface layers of the skin and plumage, forced changes in migration routes, moulting, nesting, spawning and so on.

3.2.3. Emissions to air.

Emissions of pollutants into the atmosphere go hand in hand with oil fields. The most widespread source of such emissions is the burning of casing-head gas (flaring) and surplus quantities of hydrocarbons in the course of testing and exploiting wells. According to several assessments, up to 30% of hydrocarbons which are burned in flames are released into the atmosphere and then fall on to the surface of the sea, forming relatively unstable, thin films around drilling platforms.

Climate gases come from burning of fossil fuel such as coal, oil and gas. Oil and gas activities make a significant contribution to climate change by emitting high quantities of greenhouse gases. (see appendix III-I on climate change, and appendix III-ii on the Greenhouse effect).

The bulk of these emissions come about as a result of burning oil or gas to produce energy to the production, for example burning gas in turbines. Flaring is also a problem because of the emissions it leads to. There are also some discharges from well testing and from supply ships and tankers. The emissions of climate gases are often rising when an oil field is getting "older". One reason for this is that the amount of produced water is rising, and then more energy is needed to separate the produced water from the oil.

Emissions of **CO2** (Carbon dioxide) is an significant climate gas and it is released through the burning of fossil fuel. In addition the petroleum industry is also causing smaller discharges of CH4; witch is a climate gas with a strong greenhouse effect.

Emissions of NOx: Nitrogen oxides, or NOx, are created when fossil fuel is burnt. Emissions of NOx are often closely connected to the emissions of CO2. Burning of gas in turbines and flaring are important reasons for the emissions. The environmental effects are local and regional, NOx makes land and water sour and harms humans, animals and plants. NOx can be deadly for those suffering from asthmatic or other breathing related diseases.

> **For your information:**
>
> **The United Nations Framework Convention on Climate Change (UNFCCC) determines the direction of actions undertaken across the globe in combating global warming.**
>
> The UNFCCC was adopted in June 1992 at the Earth Summit in Rio de Janeiro, its main aim being to stabilise "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". This aim was then corroborated in Kyoto in 1997 when all of the world's countries agreed that over the period from 2008 to 2012, developed countries must reduce their collective emissions of gaseous waste to 5% below 1990 levels. The Kyoto Protocol entered into force following ratification by the Russian Federation in 2004. This protocol introduces a mechanism for creating carbon credits and trading these credits within the framework of projects geared towards reducing the level of greenhouse gas emissions such as carbon dioxide (CO_2).

Emissions of nmVOC: Emissions of nmVOC (non methane volatile organic compounds) is evaporating from among others crude oil. In the petroleum industry most of de emissions of nmVoc originate from storage and loading of crud oil offshore and from the terminals onshore. When nmVOC reacts with nitrogen oxides (NOx) influenced by sun light, ozone is being created. High concentrations of ozone near the ground can damage health, vegetation and buildings

Here's a thought...

Flaring and venting of natural gas in oil wells is a significant source of greenhouse gas emissions. The World Bank estimates that 100 billion cubic meters of natural gas are flared annually, an amount equivalent to three quarters of Russian gas exports, or enough to supply the entire world with gas for 20 days[3]

Bellona's demands

- Environmental impact evaluation of oil and gas activities by independent experts on a regular basis.
- Public hearings should be arranged also regarding plans to prevent or clean up oil spills and gas leaks.
- The introduction of best available technologies (BAT), and stringent environmental standards to minimise negative impacts on the environment, to reduce greenhouse gas emissions into the atmosphere and chemical wastes into the marine environment when operating oil and gas fields.
- The establishment of petroleum-free are in particularly susceptible and valuable areas of the Arctic shelf. This restriction should be introduced where valuable and rare species of fish spawn, in nesting areas for birds, and so on. These areas should be no-go areas for the oil and gas industry.
- The industry should be obliged to take into consideration the difficult climatic conditions on the Arctic shelf. Prohibition of oil and gas activities on the Arctic shelf during periods when fish spawn and birds nest, as well as during the winter months.
- Free access to information about regular and accidental emissions to sea and air
- Public monitoring of all company activities

3.2.4. Seismic hazard

With prolonged field operation, the seismic hazard in the region in question increases, due to exhaustion of resources. As a result, under the weight of the production complex, the top layers of rock may cave in, resulting in serious environmental consequences and the loss of human life, and will also promote further dispersion of shock waves and possible earthquakes in remote regions.

Here's a thought…

As things stand, given the remoteness of the data acquisition centres (some 600-900 km from the Shtokman field), the system does not guarantee monitoring of weak earthquakes. To achieve the optimum level of sensitivity and accuracy, the creation of seismic groups on Novaya Zemlya and the island of Kolguev is necessary.[4]

<u>3.3. The Environmental risk when transporting oil and gas</u>

3.3.1. Transport by tanker

Here's a thought…

"…In Russia, only between 5 and 15% of oil emissions to the sea occur due to incidents involving vessels, platforms, pipelines and the like. The remainder comes from premeditated dumping".[5]

The risks associated with extracting and transporting oil and gas are significantly higher on the Continental shelf of Russia compared with other regions. The weather in this region is one of the worst in the world. Snowstorms and relatively large local temperature differences make it very difficult to give reliable weather forecasts. In these areas ice-covered oceans can have temperatures as low as -50 degrees Celsius, while open seas have a surface temperature of 4-6 degrees. These conditions create polar lows and snowfalls that give almost no predictability. Drifting icebergs are a problem for transportation and installations, both over and under water. Icing of boats and installations, created by the combination of wind, waves and low temperatures is a particular challenge in the Arctic. Furthermore, many other factors significantly reduce the environment's natural self-regulating ability: the specific climatic conditions, the amount of available daylight, the nature of heat transfer between the ocean's surface and the layers situated underneath and the atmosphere, the spatial distribution of the Earth's magnetic poles, the configuration of the bottom, the types of coast and shallow tides. In connection with all this, the development of intensive shipping and the establishment of offshore production facilities in this region require special attention to ensure environmental safety.

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[3] Friends of the Earth International. www.foei.org

[4] *"Seismicity on the Barents Sea shelf and ensuring geodynamic monitoring when exploiting the Shtockman gas condensate field", Vinogradov A.N., Vinogradov Yu. A. et al. - Material from the international conference entitled "Oil and gas on the Arctic shelf 2006", Murmansk, 15-17 November 2006*

[5] *"The Dark Tide: Oil in the earth's surface water" - "Bereginya, No. 6*

Work involving development of oil and gas in the coastal area and on the shelf, sharply increases the risks of polluting the aquatic environment in these regions, above all, pollution from accidental or premeditated discharge, fuels and lubricants from drilling rigs, vessels and auxiliary mechanisms, as well as discharges from working structures.

The probability of tanker accidents involving oil spills in the Russian northern seas is determined by:

- the relatively small average length of the transportation routes (less than 1,000 km compared with an average global distance in excess of 4,500 km);
- the large number of freight operations – loading on to a shuttle tanker, transfer from shuttle tankers, via waterborne terminals, to export tankers, unloading at the destination port;
- the great discrepancy in displacements between the tankers used - from 10,000 to 100,000 tonnes and above; and
- The difficult navigation conditions in the Arctic.

Statistics show that the transport of oil by tanker is as risky as pumping it by underwater pipeline.[6]

An analysis of data concerning accidental spillages over the period 1974-2004 in Russia demonstrates that the main problems, violation of safety standards and spillages, occur during loading/unloading and bunker operations at terminals. The International Marine Organization notes the following global causes of large-scale oil spills involving tankers:

- technical failure,
- grounding,
- collisions,
- Fires and explosions.

Here's a thought…

The Kandalaksha State Nature Reserve is located in the northwest of the White Sea. It was established in 1932. The terminal in the port of Vitino is located in the Gulf of Kandalaksha and vessels calling in at port pass in the immediate vicinity of the protected islands.[7]

Emergencies, including collisions and grounding (20% in excess of 700 tonnes) result in significant spillages. The most dangerous situations from the point of view of spillages are fires and explosions, although the frequency with which they occur does not exceed 1%.[8]

Bellona's demands

- Creation of a general database to collect information pertaining to oil and gas tankers which operate in Arctic shelf waters of Russia.
- The establishment of specific routes for transporting oil and gas on the Arctic shelf. These routes must be fixed, and established a sufficient distance from the coastline to minimise impact on fish spawning grounds and nesting birds.
- Prohibition of single-hulled tankers for transporting oil and gas on the Arctic shelf.
- Introduction of a sufficient quantity of well equipped tugs over the entire length of all routes for transporting oil and gas on the Arctic shelf.
- Improved planning for preventing and clearing up accidental oil spills (gas leaks) when transporting oil and gas on the Arctic shelf.
- Better Prevention, Preparedness and Response routines within the oil and gas companies and state organs.

3.3.2. Transport by pipeline

The comprehensive and branch systems of underwater pipelines pumping oil, gas and condensate are among the main environmental risk factors posed by offshore field. These pipes stretch over hundreds and thousands of kilometres.

An accident caused by a rupture in a pipeline might create tremendous consequences to marine life. The extent of the damage will depend on the size of the leak. However, accidental discharges of oil and gas in main overland pipelines, can also pose a risk to coastal marine ecosystems when these take place near, or at river intersections, since contamination of river water sooner or later impacts the state of estuarine sea areas.

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[6] *"Evaluating the risk in plans aimed at clearing up oil spills for the installations in respect of which it is transported", G.I. Turkina, N.N. Chura, V.A. Turkin - "Neftyanoe Khozyaistvo" - December 2005*

[7] *"The transportation of oil from the Russian sector of the Barents Region", A. Bambuliak, B. Frantzen - Svanhovd Environmental Centre*

[8] *"The shelf does not need oil spills" - "Neftegazovaya vertikal" journal, January 2006*

Earthworks are a main source of impact on the marine environment when constructing an underwater pipeline. This includes sinking trenches and access channels, deepening and backfilling pipelines, and dumping soil. This is accompanied by increases in the content of suspensions in water, ground deposits formed by fine fractions, or changes in the hydro geochemical characteristics of the marine environment from pollutants released from the sludge.

Here's a thought…

The Shtockman gas field is situated in a geological area within the zone of Atlantic earthquakes, which occur every 20 years. Nobody has taken this into account in their plans. What this will do to the pipeline, nobody knows[9] – Anonymous Russian researcher, Environmental Perceptions in Northwest Russia, International Politics, March 2007

The near-bottom water in the pipeline area heats up and cools down when transporting oil and gas by underwater pipelines. However, it is unlikely that there will be important temperature changes in a significant layer of the water in terms of thickness. The influence of temperature changes on benthos will be limited to a very narrow strip along the pipes. At the same time, it is impossible to fully rule out the possibility of the impact of these changes as a warning factor on migrating bottom-dwelling fish. In fact, it is precisely the unfavourable temperature of the near-bottom waters which limits the migrations of several species of fish under natural conditions, such as cod, haddock and plaice.[11]

Here's a thought…

In Russia, there are about 50,000 incidents annually resulting from approximately 350,000 km of operational oil pipeline, according to information from social environmental organisations. [10]

According to data from the "Transneft" joint-stock company, statistics of pipeline accidents showed that 31% occur as a result of structural defects, 22% because of defects in the pipes arriving from factories and 22% on account of corrosion.[12]

At present, according to estimates made by specialists from the Russian Ministry of Civil Defence, Emergencies and Disaster Relief, the number of pipeline incidents is increasing year after year. The intensive loads placed on main oil pipelines, which have transferred in excess of 500 million tonnes of oil annually since the 1980s, has resulted in a worn-out system which requires significant maintenance. Without reconstruction, accidents involving great damage to the environment and large material losses are likely in the near future.

Comments by a legal expert:

The rules governing the protection of main pipelines specify **buffer zone** boundaries:
- a parcel of land - extending for 25 m from the centre line of the pipeline on each side along its route; and
- an expanse of water between parallel planes which is 100 m away from the centre line of the outside branch transitions on each side along the water crossings.

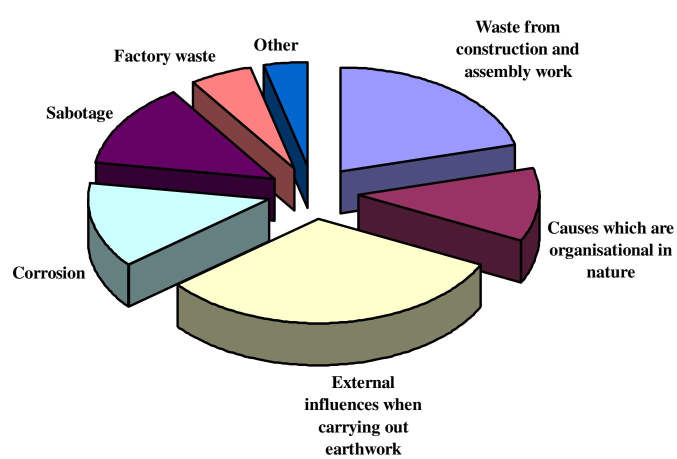
Areas of land which form part of pipeline buffer zones are not removed by land users. These areas are used by them to carry out agricultural and other work in observance of these rules.

Imperfect technologies lead to a reduction in construction quality, various defects in the metal in the pipeline walls, and reduced safety when operating gas pipelines. Protracted operating periods for gas pipelines and continually changing parameters in relation to pumping cause an increase in mechanical failures and damage to metal in the pipeline as a result of fatigue which, in turn, may lead to accidents.

In Russia, the main causes of accidents are as follows (fig. 5):[13]

- External factors - earthworks close to the pipelines, rock slides, sabotage - 45.3%,
- Defects in building and assembly work - 20.8%,
- Technical reasons - the failure of cut-offs, defective valves, defective products from the factory - 5.6%,
- Bad management - 11.3%,
- Corrosion - 13.2%,
- Other - 3.8%.

Fig.5. Causes of damage to main pipelines according to data from the State Committee for Industrial and Mining Safety Supervision



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[9] *Anonymous Russian researcher, Environmental Perceptions in Northwest Russia, International Politics, March 2007*
[10] *Gosresurs.ru*
[11] *The Polar Scientific Research Institute for Marine Fishing and Oceanography, named after N.M. Kinpovich*
[12] *www.transneft.ru*
[13] *Sutyagin A. Research undertaken by the St. Petersburg-based "Bellona" environmental human rights centre between 2003-2004*

As of 2005, the wear and tear on the basic resources of Gazprom's gas transport system exceeded 50%.[15] More than 90% of accidents to the unified gas supply system occur on a linear part of the main gas pipelines. The causes of accidents on gas pipelines in Russia are as follows:[16]

> **Here's a thought…**
> In 1989, sparks from a passing train caused gas which escaped from the gas pipeline near the town of Ufa to detonate, resulting in the death of 645 people.[14]

- Defects in the pipes and equipment (95% of the operational linear valves on the main gas pipeline do not have emergency valve shut-off systems).
- Violation of the rules relating to technical operation of gas pipelines because of inaccurate and impractical information regarding the technological parameters for gas pipeline operation

Statistics concerning gas pipeline accidents shows that in Russia there is an increased risk of accidents in the first few years of operation. This is linked to the probability at the beginning of an operation of changes in the pipeline's position, the loads it carries and the amount of stress deformation which reaches limit values in individual cases. Furthermore, such a situation arises on account of the known flaws in the methods for testing pipelines and checking the quality of the building and assembly work, and other special work, which has been carried out. [17]

According to the law *Construction norms and regulations no. 2.05.06-85**, main pipelines (pipelines for gas, oil and petroleum products)[1] should be laid underground (underground laying). The laying of pipelines along the surface in an embankment (overland laying) or on supports (elevated laying) is only permitted by way of exception when substantiated accordingly. In this connection, provision must be made for special measures which ensure reliable and safe pipeline operation.

> **Here's a thought…**
> During the period when the North Tyumen region was developed, 6 million hectares of grassland for reindeer (12.5% of the total area) was lost and 30,000 hectares of land was polluted with fuel oil. Around 73,000 hectares of forest was contaminated with gaseous emissions and chemical agents and flooded with drilling fluid and mineralised water. In individual regions, the concentration of petroleum hydrocarbons in the earth exceeds background values 150-200 fold.

In accordance with *Sanitary norms and regulations no. 2.2.1/2.1.1.1200-03*, provision is made for minimum distances from construction elements depending on the pipe diameter. Hence, with pipe diameters of up to 300 mm, the distance from the town or settlement must be 75 m, and 50 m from single low dwellings.

> **Here's a thought...**
> As reported in the St. Petersburg Times, according to Konstantin Pulikovsky, head of the Federal Service for Ecological, Technical and Nuclear Supervision, Russia's pipeline transport system is in a bad state. "The environmental damage inflicted by pipelines is inexcusable", he states.[18]

In accordance with the "*Guidelines for safeguarding main pipelines"* (dated 29.04.1992, as amended on 23.11.1994), pipeline routes are designated by identification markings (with destination boards) 1.5 - 2 m high above the surface of the ground, installed at the limit of direct visibility, but at least every 500 m, and at bends.

> ***Bellona's demands***
> - Obligatory integrated environmental impact assessment and systematic monitoring of pipeline functioning.
> - Application of best available technology (BAT) and stringent environmental standards that minimise negative environmental impact of the pipeline.
> - Regulatory measures that limit the territory violated during construction of oil and gas pipelines. Preservation of animal migration routes.
> - Compensation to inhabitants for environmental damage incurred as a result of project activities.

3.3.3 Transport by railway

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[14] *http://en.wikipedia.org/wiki/Pipeline_accidents*

[15] *"The principal ways of increasing the reliability and safety of Gazprom's gas transport systems - B.V. Budzuliak (the "Gazprom" public company) - Gazovaya promyshlennost, August 2005*

[16] *"Smart systems for ensuring the industrial and environmental safety of main gas pipelines", S.M. Kudakaev, F.M. Aminev, V.F. Galiakbarov et al.- Gazovaya promyshlennost, May 2004*

[17] *Code of the regulations on construction of trunk gas pipelines. Developed by the Association High-Reliable Pipeline Transport, RAO GAZPROM, RAO Rosneftegazstroy, All-Russia Pipeline Construction Scientific and Research Institute, Russian Research Institute for Natural Gases and Gas Technologies, Paton Electric Welding Institute.*

[18] *www.bellona.ru*

The State supervision of railways is handled by the Federal Agency for Railway Transport under the Russian Ministry for Transport.

On public railways, measures for ensuring environmental safety and fire safety is handled by the infrastructure owners, carriers, organisations and individual manufacturers performing ancillary work (services) for shipments by rail, in accordance with the legislation of the Russian Federation (Federal Law No. 17 dated 10.01.2003, as amended on 07.07.2003 "regarding rail transport in the Russian Federation).

The transport of oil and gas by rail in tank wagons is no more reliable than transport by pipeline or tanker. The following have been identified among the reasons for accidents and incidents resulting in the leaking of petroleum products or crude oil from railway tank wagons:

- infringements of regulations concerned with handling dangerous loads; and
- human error and bad management.
- derailments, as a result of unfavourable natural climatic conditions,;
- train collisions;
- mechanical impact on the train;
- collapsing bridges;
- sparking, with the subsequent ignition of the contents of the wagons;

The consequences of the accidents may be very serious: fire, contamination of soil and drinking water by petroleum products, destruction of ecosystems, extinction of living organisms as well as possible human losses.

Fuel oil spill due to a derailment involving petroleum products in Tvyor oblast

On June 15, 2005, 26 of 60 tank wagons transporting fuel oil derailed near Rzhev (Tvyor oblast). Twenty-four of the 26 wagons overturned. According to certain sources, approximately 300 tonnes of petroleum products leaked out of these tank wagons, some of which entered the Vazuza River before flowing into the Volga. Samples of water taken from the Vazuza showed that the content of harmful substances was more than 100 times above the norm. Fish deaths were observed. There was a threat of reservoir contamination of Moscow's drinking water.

Oleg Mitvol, deputy head of the Federal Service for Supervision of Natural Resource Usage, declared it to be "an environmental disaster on a national scale". This accident cast doubt on the indisputable safety of shipments of oil and petroleum products by railway.

According to the public company "Rossiskiye zhelezniye dorogi", waterlogging of the track because of waste water from the adjoining small river caused the accident. The poor technical condition of the rolling stock was also cited as a contributing factor. Following the accident near Rzhev, the environmental prosecutor's office responsible for the Volga region instituted criminal proceedings according to Section 2 Article 247 of the Criminal Code of the Russian Federation: "The infringement of rules for dealing with ecologically hazardous substances which resulted in pollution of the environment".

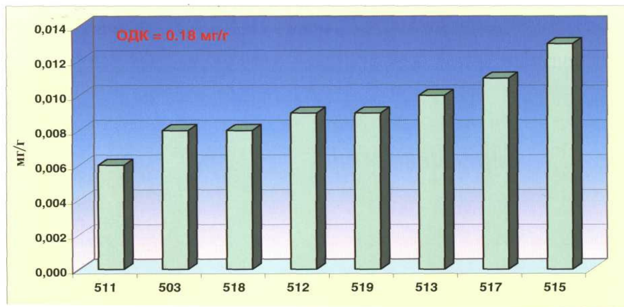
"*I was staggered by the complacency and to whi*ch *extent the situation had been underestimated, including the covering up of information regarding the oil entering reservoirs, the Volga River in particular",* observed Soldatova, speaking about the first few hours following the accident. *"The executive authorities in Tvyor oblast, having belatedly taken charge of the headquarters for dealing with the accident, and other bodies, appeared ill-prepared to act in an emergency situation. Rules for dealing with oil spills were affirmed by means of a resolution from the Government of the Russian Federation. In accordance with point 7 of these rules, when receiving reports of oil spills, the period for localising the spill should not exceed four hours in the event of a spill into the sea, and six hours in the event of a spill on land. However, these norms were increased more than two fold. There was practically no co-ordination between the various services. The agents to eliminate oil spots in the water and on shore were not used in a timely manner. Despite the emergency situation, the general population was not provided with any information on fishing bans, or bans on grazing, cattle watering holes or bathing. Water and soil samples were taken within 12 hours of the accident and only at the request of the public prosecutor, which literally forced workers* (from the Federal Service for Supervision of Natural Resource Usage, and the Federal Agricultural Inspectorate, etc*.) to travel to the site. The attention of the local population was only drawn to the cleaning up of the accident 1-2 days after it had occurred. This won't do at all".*[19]

[19] *http://www.gazeta.ru/2005/06/22/oa_161546.shtml*

3.4. The state of the environment in the Pechora, Barents (Kola Gulf) and White Seas[20]

Research undertaken by the "Sevmorgeo" Federal State unitary scientific and production enterprise demonstrate that in 2005, the concentrations of petroleum products in the near-bottom waters of the Pechora Sea increased.

Fig.6. Concentrations of petroleum products in the near-bottom waters of the Pechora Sea, October, 2005



Furthermore, in the bottom sediments of the Kola Gulf, the concentrations of petroleum products in 2005 exceeded maximum permitted pollution levels by ten fold.

Fig.7. Concentrations of petroleum products (mg/l) in the near-bottom waters of the Kola Bay, September, 2005

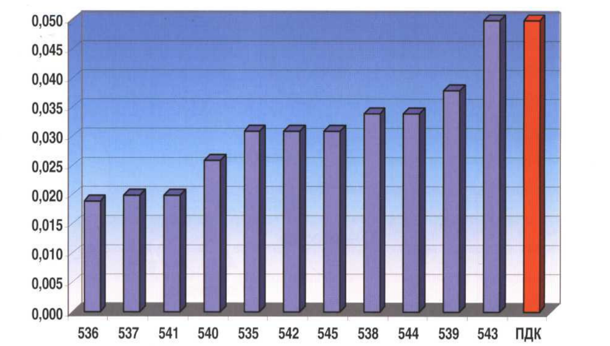
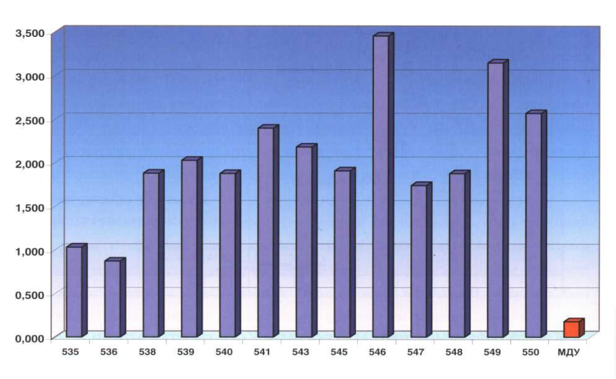


Fig.8. Concentrations of petroleum products (mg/g) in the bottom sediments of the Kola Bay, September, 2005



In the Barents Sea, the bottom sediments are the most polluted, thereby creating the risk of secondary contamination of near-bottom waters and a sharp deterioration in the conditions of the ecosystem as a whole, even with an insignificant increase in industrial pressure.

In the White Sea, the geo-ecological situation is continuing to deteriorate in the Gulf of Kandalaksha, in particular, in the area of the Vitino terminal, where increased concentrations of petroleum products in the near-bottom waters have been established.

Fig.9. Change of the concentrations of petroleum products in the near-bottom waters of the White Sea (Kandalaksha) in 2001-2005[21]

Fig.10. Change of the concentrations of petroleum products (mg/l) in the bottom sediments of the White Sea (Kandalaksha) in 2001-2005[22]

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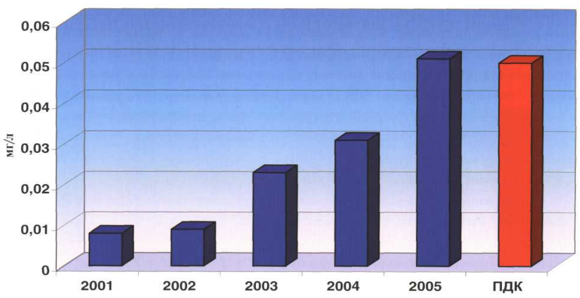
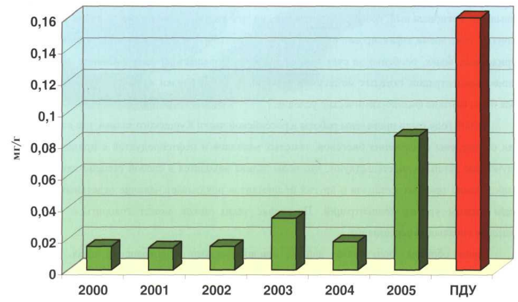
[20] *"The state of the geological environment of the Continental shelf of the Barents, White and Baltic Seas" - information bulletin published by the "Sevmorgeo" Federal State unitary scientific and production enterprise, St. Petersburg, 2005*

[21] ПДК – maximum permitted level

22 ПДУ – maximum permitted concentration





Conclusions

1. The risks associated with development of oil and gas fields and transporting of oil and gas are considerably higher on the Continental shelf of the Russian Federation, than in other regions. This is due to:

- the difficult natural climatic conditions;
- the need to employ unique technologies and equipment;
- the inadequate level of infrastructure development;
- the imperfect nature of the normative base; and
- the large number of freight operations, caused by small tankers operating in Russian waters reloading to super tankers used for export.

2. The field development process results in large quantities of emissions into the atmosphere and the marine environment, thereby significantly increasing the risks to the Arctic environment.
3. Oil and gas activity is one of the main sources of greenhouse gases which form from burning fossil fuels and cause climate change.
4. When a field is exploited over a long period of time and intensive depletion of the rock occurs, the risk of seismic activity in neighbouring territories increases, as does the possible collapse of the upper earth layer.
5. The older the field, the greater the quantity of produced water and rock fragments containing high amounts of oil and chemicals. There is currently no perfect system for purifying water and rock masses.
6. The technical implementation of the system for transporting oil and gas in Northwest Russia is at a very low level, which heightens the level of ecological risk and man's impact on the environment.
7. The intensive load placed on the main pipelines has resulted in pipeline fatigue in the majority of the system which now requires significant maintenance. The accident rate involving pipelines rises year after year, thereby increasing the risk of an environmental disaster.
8. Statistics show that the transport of oil by tanker is as dangerous as pumping it by underwater pipeline. The main problems of violation of safety standards and spillages occur during loading/unloading and bunker operations at terminals.
9. Accidents which occur when transporting oil and gas in railway tank wagons can lead to devastating fires, contamination of drinking water, destruction of ecosystems, extinction of living organisms and human losses.
10. An analysis of the state of the geological environment of the Barents, White and Pechora Seas shows that the oil product content of the water and sediment deposits of the fields in question attains, or even exceeds, the permissible concentration limits.

APPENDIX III-i "Climate Change"

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Topic: Climate change

Human-induced greenhouse effects cause climate change

Burning of fossil fuels (oil, gas, and coal) produces the greenhouse gas carbon dioxide (CO_2) that is released into the atmosphere. Greenhouse gases warm the atmosphere by trapping solar radiation. The more greenhouse gases, the more solar radiation is trapped in the atmosphere, and the warmer the earth gets, hence CO_2 emissions lead to global warming. Global warming leads to climate change. The climate is by far the most important regulator of earth processes and a change in climate properties will have a major impact on all the living, from plants to humans.

The three main indicators of global warming are temperature, precipitation, and sea level:

- The mean global surface temperature has increased by about 0.3 to 0.6°C since the late 19th century. The warming has not been globally uniform. The recent warming has been greatest between 40°N and 70°N and the highest expected temperature increases is most likely to be found in the Arctic due to loss of sea ice, which at present reflects much of the solar radiation. This will lead to positive feedback mechanisms and enhanced global warming. The mean global temperature is expected to increase 1.4 to 5.8°C by 2100.
- Precipitation has increased over land at high altitudes in the northern hemisphere, especially during the cold season. The amount of rain falling during heavy rain events has increased in some areas, such as the USA, the former Soviet Union and China. Extreme weather events are expected to occur more frequently than previously.
- Over the last 100 years the global sea level has risen by about 4 to 14 cm. The expected rise of sea level in the 20th century expands 1 to 7 m. If the entire ice cap of Greenland melts, the sea level will rise 7 m. Many researchers claim that if the temperature increase is more than 3°C a climate tipping point is reached, and such large sea level rises can be experienced.

Climate change effects in the Arctic

In the Arctic, loss of permafrost regions triggers erosion and subsidence, change hydrologic processes, reduce the stability of slopes and thus increase incidences of slides and avalanches. This threatens oil pipelines and all structures that are built on permafrost. Already melting permafrost is causing great structur damage to roads and buildings in Alaskan and Siberian areas. Change in weather patterns has also caused massive storms and subsequent floods and more storms in the northern hemisphere have increased the wave height in the North Atlantic Ocean. Climate change also causes loss of sea ice habitats which will threaten the existence of polar bears and other ice-associated animals. For example, the Barents Sea will probably be ice-free year-round by 2050, with detrimental consequences for the productive marginal ice flora and fauna.

APPENDIX III-ii “Green house effect”

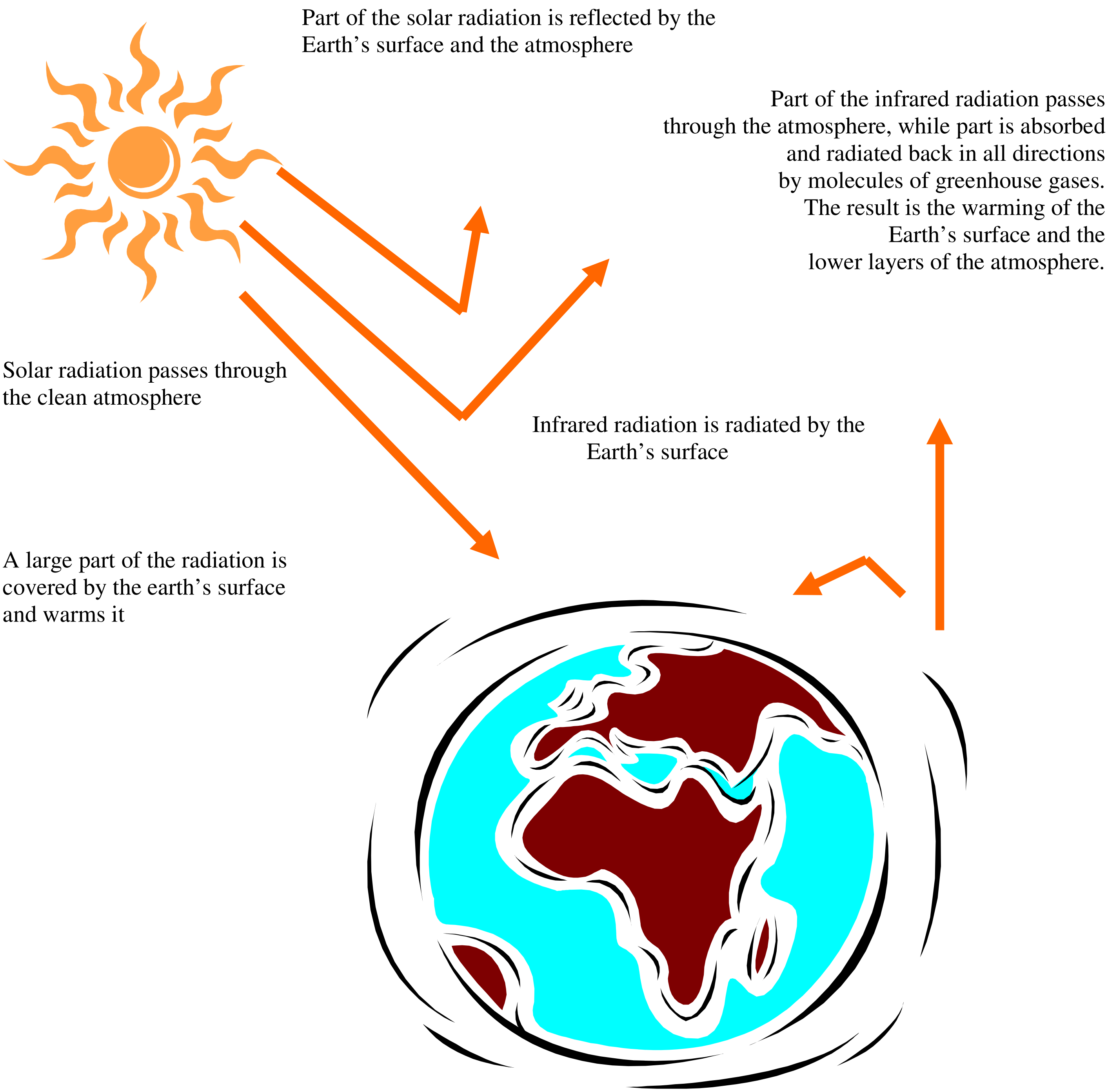

Fig. Diagram illustrating the greenhouse gas effect[1]

The majority of Solar energy is absorbed by the surface layers of the oceans and dry land and then radiated back into space in the form of long-wave (infrared) radiation. However, a certain part of the discharged radiation is absorbed in the atmosphere as so-called greenhouse gases (in the first instance, water vapour, carbon dioxide (CO_2), methane (CH_4) and several others), which ensures additional heat build-up on the Earth’s surface - **the Greenhouse effect**.

[1] *http://www.ecoenergy.ru/Articles/Article5.html*