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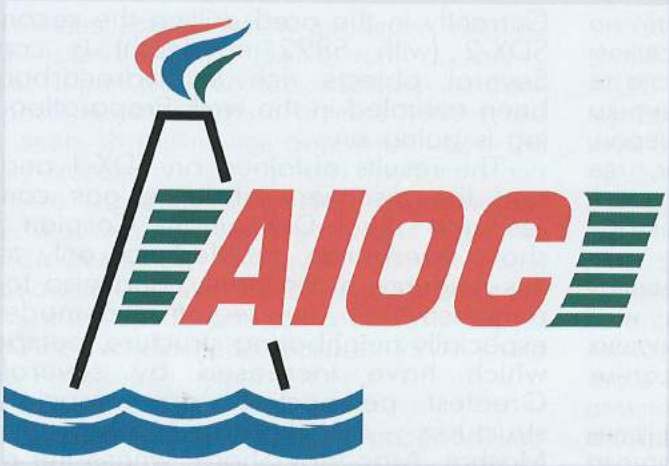


AZERBAIJAN'S FIRST PROFIT OIL ACHIEVED

Добыча Первой Азербайджанской Прибыльной Нефти

АМОК, оператором которой является компания БиПи Амоко, и Государственная Нефтяная Компания Азербайджанской Республики рады сообщить, что 22 декабря из Супсы первый танкер приблизитель-но с одним миллионом баррелей Азербайджанской прибыльной нефти был отгружен компанией "ТоталФина", которая закупила эту нефть. Погрузка первой партии Азербайджанской Прибыльной нефти на танкер "Берч" началась 19 декабря в Супсе, а вчера, в 21:48 часов тан-кер отбыл в направлении Лаверы, Франция.

Отгрузка первой Азербайджанской прибыльной нефти означает, что в четвертом квартале 1999 г. суммарные эксплуатационные расходы, по-несенные по настоящий момент Иностранными нефтяными компания-ми и Государственной нефтяной компанией Азербайджанской Респуб-лики (ГНКАР) в связи с эксплуатацией месторождения Чыраг, эксплуа-тацией Северного маршрута экспортного трубопровода (СМЭТ) и За-падного маршрута экспортного трубопровода (ЗМЭТ) в рамках Согла-шения о совместной разработке и долевом распределении добычи на месторождениях Азери и Чыраг и на глубоководной части месторож-дения Гюнешли, были возмещены. Теперь все компании-участницы Соглашения получают свои доли Прибыльной нефти. До добычи Прибыльной нефти, ГНКАР заключала соглашения с различными Иностранными нефтяными компаниями на отгрузку нефти в соот-ветствии с долей ГНКАР в ССРДРД. Теперь, после добычи Прибыль-ной нефти, ГНКАР

AIOC, operated by BP Amoco, and the State Oil Company of the Azerbaijan Republic (SOCAR) are pleased to announce that on December 22 the first tanker with Azerbaijan's approximately one million barrels of prof-it oil was lifted from Supsa by TotalFina, who have purchased the oil. The Tankship "Birch" began loading the first cargo of Azerbaijan's Profit Oil at Supsa on December 19 and sailed yesterday at 2 1:48 hours to its destination at Lavera, France.

The first lifting of Azerbaijan's profit oil indicates that in the fourth quarter of 1999 the cumulative operating costs incurred to date by the Foreign Oil Companies and the State Oil Company of the Azerbaijan Republic (SOCAR) in operating the Chirag field, the Northern Route Export Pipeline (NREP) and the Western Route Export Pipeline (WREP) tinder the Azeri, Chirag and Deepwater Gunashli Production Sharing Agreement have been recovered. All the participating companies are now receiving their share of Profit Oil. Before Profit Oil, SOCAR entered into agreements with various Foreign Oil Companies to lift the oil associated with SOCAR's equity share in in the PSA. No", with the achievement of Profit Oil, SOCAR is lifting and selling its own Chirag crude oil cargoes.

Natig Aliyev, President of SOCAR, says: "Azerbaijan's first Profit Oil from the Chirag field marks one the most remarkable events among the accomplishments we have achieved since we began implementing the Contract of Century. It once again indicates that President Heydar Aliyev's oil strategy is

отгружает и продает собственнную сырую нефть, добытую на месторождении Чы-раг.

Натиг Алиев, президент ГНКАР, говорит: "Продажа первой партии Азербайджанской прибыльной нефти с месторождения Чыраг- одно из самых значительных достижений со времени претворения в жизнь "Контракта века". Это событие является еще одним свидетельством успешной реализации нефтяной стратегии уважаемого президента Азербайджанской Республики, господина Гейдара Алиева. В ближайшие годы объем прибыльной нефти будет возрастать, и, обеспечив при-ток валюты в нашу страну, серьезно повлияет на развитие экономики Республики и повышение благосостояния нашего народа".

Дэвид Вудворд, Президент АМОК, говорит: "Добыча первой Прибыль-ной нефти в четвертом квартале 1999 г. стала результатом отличных показателей по добыче и по управлению расходами в АМОК в течение всего года. Это является выдающимся событием, отмечающим начало получения Азербайджаном крупных прибылей от контрактов, которые были подписаны в стране с иностранными нефтяными компаниями по совместной разработке энергетических ресурсов. Мы поздравляем азербайджанский народ, Правительство Азербайджана и ГНКАР с этой важной вехой и огромным успехом в нашем партнерстве".

ПРЕСС-РЕЛИЗ
23 декабря 1999 г.

АМОК- Информация о деятельности компании

24 декабря, 1999г.

Встреча с Девидом Вудвордом, Президентом АМОК и Рашидом Джаванширом, Президентом СДРД БиПи Амоко Эксплорейшн

1999г. был успешным годом для АМОК. В этом году мы достигли замечательных показателей по безопасности производства -всего 0,9 случаев потери рабочего времени в результате аварии (ПВА) на мил-лион человеко-часов в прошлом году. Это стало возможным благодаря нашему стремлению непрерывно совершенствовать свои показатели по безопасности производства может служить Сангачальский терминал, где недавно отметили вторую годовщину работы без единого случая потери рабочего времени в результате аварии. Отмечая наши успешные достижения в 1999 г., мы ставим перед собой еще более высокие задачи -0,7 ПВА на миллион человеко-часов в 2000 г.

becoming a reality. Profit Oil volumes will continue to increase in the coming years providing a currency flow to our Country and significantly promoting the development of the republic's economy and the public welfare."

David Woodward, President of AIOC, says: "The achievement of first Profit Oil in the fourth quarter of 1999 is a result of outstanding production and cost management performance in AIOC throughout the year. This is a significant event markin g the beginning of the major benefits Azerbaijan will receive from the contracts the country has signed with foreign oil companies to jointly develop its energy resources. We congratulate the people of Azerbaijan, the Azerbaijan Government and SOCAR on this important milestone. and the outstanding success Of Our partnership."

PRESS RELEASE
December 23. 1999

AIOC Business Update

December 24, 1999

Meeting with David Woodward, AIOC President, and Rashid Djevanshir , BPAmoco Exploration PSAs President

1999 has been a successful year for AIOC. We have achieved an outstanding safety performance this year with 0.9 LTI per million man-hour in comparison to 2.7 LTIs per million man-hour last year. This has been achieved as a result of our full commitment to continuously improving our safety performance as our first priority. As part of our safety objectives the Sangachal terminal recently celebrated two years without a single lost time incident (LTI) target achievement. While we celebrate this major success in 1999 we set a challenging target to reach 0.7 LTI per million man-hour result in 2000.

Other major achievements of 1999 have included:

. The completion and commissioning of the Western Route Export Pipeline (WREP) from Baku to Supsa which was officially celebrated on the Azerbaijan and Georgian governmental level on April 17, 1999 at Supsa where President Heydar Aliyev, President Eduard Shevardnadze, and President Leonid Kuchma of Ukraine inaugurated the Western Route transportation system. The first tanker with 600.000 barrels of Chirag crude oil was lifted from Supsa on April 8, 1999 bv BP. Since we began pumping our crude oil from the Chirag platform into the WREP last December, the system has demonstrated successful transportation performance with improving reliability and economics by delivering Caspian oil directly to world markets. To date we have exported some 24

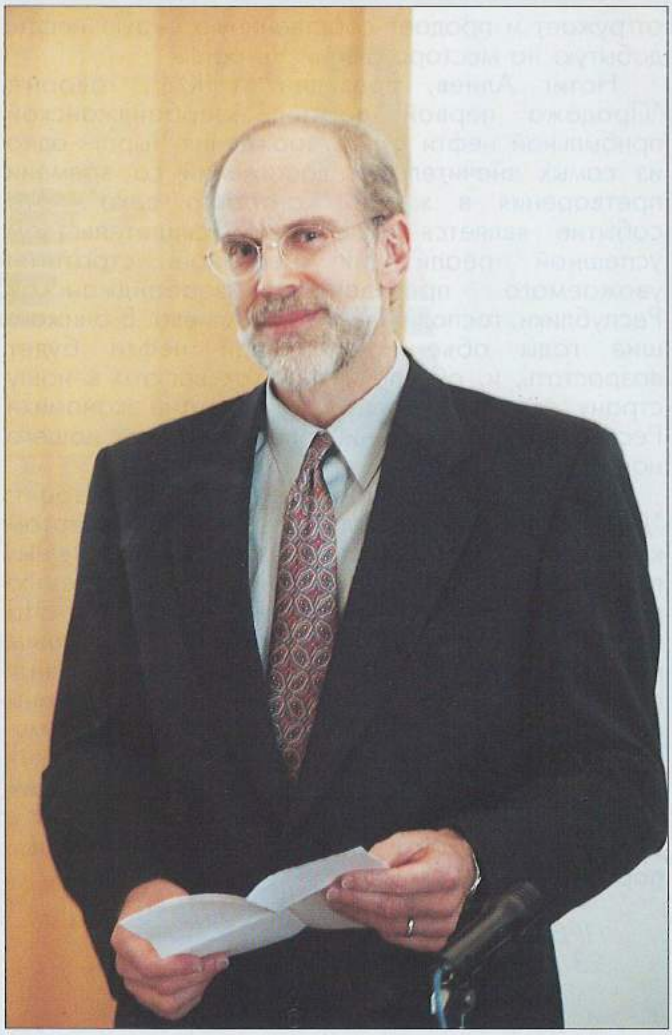
В число других достижений 1999 г. входят следующие:

. Завершение строительства и пуск в эксплуатацию Западного маршрута экспортного трубопровода (ЗМЕТ), проходящего из Баку в Супсу, отмечалось на уровне правительств Азербайджана и Грузии 17 апреля 1999 г. в Супсе, где Президент Гейдар Алиев, Президент Эдуард Шеварднадзе и Президент Украины Леонид Кучма, торжественно открыли транспортную систему западного неправления. Первый танкер с 600 тысячами баррелей сырой нефти добытой с платформы Чираг было отправлено из Супсы 8 апреля компанией БиПи. С момента начала закачки нашей сырой нефти, добытой на платформе Чираг, в систему ЗМЕТ в декабре прошлого года, система демонстрировала отличные показатели по транспор-тировке, наряду с повышающейся надежностью и экономической рентабелностью доставки Каспийской нефти непосредственного на мировые рынки. Вплоть до настоящего момента, по ЗМЭТ было экспортировано на мировые рынки около 24 миллионов баррелей нефти с месторождения Чыраг, что позволило нашим акционерам отгрузить 32 танкера (включая отгрузки прибыльной нефти Азербайджана) этой высококачественной Азербайджанской легкой сырой нефти из Супсы. В настоящее время трубопровод работает на полную мощность, пропуская около 115,000 баррелей в сутки от Сангачальского терминала, рпасположенного недалеко от Баку, до Супсы. Успех ЗМЕТ стал возможен благодаря поддержке и сотрудничеству Азербайджанского правительства и ГНКАР по Азербайджанской секции, и Грузинского правительства и ГМНК по грузинской секции трубопровода.

. В июне, после соответствующего решения акционеров по Соглашению о совместной разработке и долевом распределении добычи на месторождениях Азери, Чыраг и глубоководной части месторождения Гюнешли, оператором АМОК стала компания БиПи Амоко. Цель этих изменений заключалось в том, чтобы повысить эфективность и обеспечить более четкую подотчетность, а также более направленную операционную и техническую поддержку со стороны БиПи Амоко. До сих пор результаты деятельности БиПи Амоко в качестве единого оператора были весьма успешными, на благо акционеров и Азербайджана.

. В сентябре мы закончили бурение наклонно-направленной скважины А-14z с морской платформы Чыраг-1, что стало еще одним рекордом по бурению в Каспийском море и ознаменовало собой завершение 1-ой Стадии буровых работ с платформы Чыраг-1. А-14z - добывающая скважина с общей глубиной 5424 м. и с рекордным расстоянием от платформы в 3971м. Предыдущий рекорд по максимальному отклонению скважины от горизонтали на 3551м. также был установлен с платформы Чыраг1.

. В ноябре, во время Саммита ОБСЕ в Стамбуле, Азербайджан, Грузия и Турция подписали Межправительственное Соглашение (МПС) в



million barrels of Chirag oil to world markets via the WREP and this has enabled our shareholders to lift some 32 tankerloads (including Azerbaijan's profit oil lifting on December 22) of this high value Azeri light crude from Supsa. Today the pipeline operates at its full capacity carrying about 11 S. 000 bpd from our Sangachal terminal near Baku to Supsa. The success of WREP has become possible through the support and cooperation with the Azerbaijan government and SOCAR on the Azerbaijan section, the Georgian government and GIOC on the Georgian section,

. In June following a decision by the shareholders of the Azeri, Chirag and Deepwater Gunashli Production Sharing Agreement BP Amoco assumed management of AIOC's operatorship. This change was designed to ensure increased efficiences, improved operator accountability, as well as more direct operational and technical support from BP Amoco. So far the results of BP Amoco's single operatorship have been very successful to the benefit of our shareholders and Azerbaijan.

. In September we completed A- 14z directional well from the Chirag- I offshore platform with another Caspian Sea drilling record and this marked the completion of the Chirag Stage I drilling. A- 14z is a production well with a total depth of 5,424 metres and a record total distance of 3,971 metres from the platform. The previous Caspian Sea record of 3551 metres for maximum well departure was also held by the Chirag- I platform.

поддержку Основного экспортного трубопровода Баку-Тбилиси-Джейхан (БТД). Подписание этого Соглашения стало значительным достижением Азербайджанской рабочей группы под руководством Заместителя Премьер-Министра Абида Шарифова. АМОК, вместе с другими членами Азербайджанскойрабочей группы, напряженно работала в течение последнего года, обсуждая ряд соглашений по ОЭТ Баку-Тбилиси-Джейхан. После подписания Соглашений с правительством транзитных стран с Грузинской и Азербайджанской стороной, соглашения будут представлены в парламенты Азербайджана, Грузии и Турции на ратификацию. После ратификации, привительства этих стран направят свои усилия на создание Организационной группы потенциальных инвестеров с целью дальнейшего развития проекта. Отдельные нефтяные компании получают возможность принять решение о своем участии в работе Организационной группы. На прошлой неделе в Тбилиси официально возобновились переговоры с Грузинской рабочей группой в попытке прийти к соглашению по поводу нерешенных вопросов в Соглашении с правительствами транзитных стран (СПТС).

. В декабре правительство Азербайджана и акционеры по Соглаше-нию о совместной разработке и долевом распределении добычи на месторождениях Азери, Чыраг и глубоководной части месторож-дения Гюнешли, в результате успешной добычи в течение всего года, добыли свою первую прибыльную нефть с месторождения Чыраг. Первый танкер с одним миллионом баррелей Азербайд-жанской прибыльной нефти был отгружен из Супсы всего 2 дня назад, 22 декабря. Это выдающееся событие, отмечающее начало получения Азербайджаномкрупных прибылей от контрактов, которые были подписаны в стране с иностранными нефтяными компаниями по совместтной разработке энергетических ресурсов.

До настоящего времени мы уже инвестировали в свои операции в Азербайджане свыше 2 миллиардов долларов США, и ориентиро-вочная прибыль Азербайджана до конца 1999 г. составит около 900 миллионов долларов США. Эти средства были направлены в экономику страны в виде подписных бонусов, заработных плат местного персонала, контрактов с местными компаниями и оплат арендованных объектов ГНКАР, подоходных налогов и налога с заработной платы.

В настоящее время мы опережаем свои обязятелства по ССРДРД в отношении развития местных кадров нащей организации. 30%-ое сокращение количества иностранных сотрудников, нанятых с января 1999 г., привело к 5%-ому увеличению процентного соотно-шения Азербайджанских профессиональных кадров, которые в настоящее время составляют свыше 60% профессионального персонала компании. Инициативы по дальнейшему развитию квалификации местных кадров будут продолжаться и впредь, так чтобы они были полностью подготовлены принять на себя допол-нительные обязанности.

. In November, during the OSCE Summit in Istanbul, Azerbaijan, Georgia and Turkey signed an Intergovernmental Agreement (IGA) specifically in support of the BakuTbilisi-Ceyhan (BTC) Main Export Pipeline. This was a significant milestone achieved by the Azerbaijan Working Group under the leadership of Deputy Prime Minister Abid Sharifov. AIOC, together with the other members of the Azerbaijan Working Group, has worked hard over the last year to negotiate a set of agreements on the Baku -Tbilisi-Ceyhan MEP. Once the Host Government Agreements (HGAs) have been concluded with Georgia and Azerbaijan, the agreements will be submitted to the parliaments of Azerbaijan, Georgia and Turkey for ratification. Upon ratification, we understand that the governments will seek to encourage the formation of a Sponsor Group of potential investors to take the project for-ward. Individual oil companies will have an opportunity to decide their participation in a Sponsor Group effort. Negotiations with the Georgian Working Group formally resumed in Tbilisi last week in order to try and reach agreement on the outstanding issues in the HGA.

. In December the Azerbaijan Government and the shareholders of the Azeri, Chirag and Deepwater Gunashli Production Sharing Agreement received their first profit oil from Chirag as a result of the successful production performance throughout the year. The first tanker with Azerbaijan's approximately one million barrels of profit oil was lifted from Supsa just 2 days ago on December 22 at 21:48 hours. This is an outstanding event marking the beginning of Azerbaijan's major benefits from the contracts the country has signed with foreign oil companies to jointly develop its energy resources.

To date through our operations in Azerbaijan we have already invested over $2 billion and estimated revenues to Azerbaijan by the end of 1999 are $900 million. This has flowed into the economy of this country in the form of signature bonuses, salaries of the national staff, contracts with local companies and lease payments to SOCAR, income and withholding taxes.

Today we are exceeding our PSA commitments to developing our national staff within the organisation. 30% reduction in the number of expatriates employed since January, 1999 has resulted in the 5% increase in the percentage of Azerbaijan national professionals who now make over 60% of the company professional staff. Initiatives to further develop the skills of national staff will be continued so that they are fully prepared to take on additional responsibilities.

AIOC currently produces 100.000 bpd (5 million tonnes per year) from the Chirag platform. In addition to the volumes exported via the WREP we have pumped about 8 million barrels of oil through the Northern Route Export Pipeline (NREP) since the beginning of 1999 enabling our shareholders to lift 13 tankerloads of Chirag oil from Novorossiysk. As the operator of the Azerbaijan section of the NREP we have also continued to pump SOCAR crude into that line enabling them to lift 7 tankers from Novorossiysk in 1999.

В настоящее время АМОК добывает 100.000 баррелей нефти в сутки (5млн. тонн в год) с платформы Чыраг. Помимо тех объемов, что были экспортированы по ЗМЭТ, с начала 1999 г. мы откачали около 8 миллионов баррелей нефти по Северному маршруту экспортного трубопровода (СМЭТ), что позволило нашим акционерам отгрузить 13 танкеров с месторождения Чыраг из порта Новороссийск. Будучи операторами Азербайджанской секции СМЭТ, мы продолжали закачивать в эту трубопроводную систему сырую нефть ГНКАР, и из Новороссийска в 1999 г. было отгружено 7 танкеров нефти ГНКАР.

За последний год была разработана концепция Этапа 1, представляющая собой заманчивую инвестиционную возможность для акционеров АМОК, в соответствии с которой удается достичь показателей верхнего квартала по разработке в 1,5 миллиардов баррелей нефти при расходах, меньше чем 2 доллара США за баррель. Концепция Этапа 1 включает в себя: строительство буровой платформы с жилыми блоками на 48 скважин, с мощ-ностью добычи равной 300.000 баррелей нефти в сутки; прокладку 30" подводного трубопровода для транспортировки нефти с платформы Этапа 1 и с платформы Чыраг 1 до Сангачал; расширение Сангачальского терминала для приема увеличиваю-щихся объемов суточной добычи нефти; конверсию 25" нефте-провода, идущего от платформы Чыраг 1 в газопровод, с целью транспортировки добываемого газа на берег в Сангачалы; и, возможно, установку компрессорной платформы, с которой добываемый газ будет обратно закачиваться в пласт для поддержа-ния пластового давления.

В 1999 г. эксплуатационные расходы АМОК составили 107 млн. долларов США, в то время, как капитальные орасходы составили 212 млн. долларов США, по сравнению со 131 млн. долларов США и 467 млн. долларов США, соответственно, в 1998 г. В 2000 г. наша запланированные эксплуатационные и капитальные расходы составят 101 млн. долларов США и 210 млн. долларов США, соот-ветственно.

Учитывая свое долгосрочное присутствие здесь, в Азербайджане, АМОК, оператором которой является БиПи Амоко, продолжает стремиться к созданию образа компании, являющейся хорошим членом собщества. В 1999 г. наш вклад в дела сообщества был направлен на развитие образования, науки и гуманитарных проектов в поддержку беженцев, вынужденных переселенцев, сирот и других групп нуждающихся людей. К числу крупных проектов 1999 года относятся: Совершенство в образовании, Премия молодым ученым, Детский фестиваль мугама, Проекты школьной поддержки ЗМЭТ и СМЭТ, организация Новогоднего праздника и Праздника Новруз для детей - сирот и беженцев.

Подводя итоги 1999 г., мы смотрим в будущее, определяя осонов-ные работы, которые нам предстоит выполнить в 2000 г. Несмотря на то, что Годовая рабочая программа и бюджет на 2000 г. еще должны быть утверждены Руководящим комитетом, мы предпо-лагаем, что среднегодовая добыча составит 100.000 баррелей в сутки. Также планируются работы по дальнейшей разработке месторождения Чыраг, что позволит увеличить добычу на 10-20% в последующие годы. Также, в число работ в следующем году войдет бурение оценочной скважины GCA-6 и зарезка бокового ствола 6z. К числу других крупных работ относится участие в Азербайджанской рабочей группе по завершению переговоров по ОЭТ и деталь-ное проектирование Этапа 1 Полномасштабной разработки место-рождений АЧГ.

Over the last year, the Phase I concept has taken shape resulting in an investment opportunity for the AIOC shareholders that is very attractive, yielding a top quartile development of 1.5 billion barrels at less than $2 per barrel. The Phase I concept includes a 48 slot drilling and quarters platform capable of producing over 300,000 barrels per day; a 30" subsea pipeline to transport the oil from Phase I and Chirag I to Sangachal; an expansion of the Sangachal Terminal to process the increased daily oil production; conversion of the 24" Chirag I oil line to gas service, allowing produced gas to be delivered to shore at Sangachal; and the option to install a compression platform which would reinject produced gas into the reservoir for pressure maintenance

In 1999 AIOC's operational expenditures have amounted to $107 million while our capital expenditures have been $212 million in comparison to respectively $13 1 million and $467 million in 1998. Our 2000 opex and capex targets are projected to be $101 million and $210 million respectively.

With its long-term presence in Azerbaijan AIOC, operated by BP Amoco, remains committed to being a force for good as a corporate citizen. In 1999 our-involvement in the community has focused on educati on, science, humanitarian projects in support of refugees, IDPs, orphans and other groups of needy people. Major projects of 1999 have been Excellence in Teaching, Young Scientist Award, Children's Mugham Festival, WREP and NREP School Support Projects, New Year and Novruz Parties for orphans and refugee children.

While we summarize 1999 results we also look to the future defining our major activities in 2000. Although our 2000 Annual Work Programme and Budget is still to be approved by the Steering Committee, we anticipate annual production of 100.000 bpd. Work is also planned to develop Chirag further, to allow production to be increased by 10-20% in subsequent years. Next year's operations are also expected to include the drilling of appraisal well GCA-6 and 6z sidetrack. Other major activities will include participation in the Azerbaijan Working Group to finalize MEP negotiations, and progressing Phase 1 of ACG Full Field Development detailed engineering.

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Round Table in BP Amoco:
Круглый стол в БиПи Амоко:

Environmental Monitoring and Scientific Research Activity on the Azeri - Chirag - Guneshli Contract Area

Экологическая деятельность по Мониторингу и Научным Исследованиям на Контрактной площади Азери–Чираг–Гюнешли.

Участники:

Али Абдуллаев заместитель директора по научной работе по вопросам охраны окружающей среды Института "Азгипроморнефтегаз", кандидат технических наук

Агамахмуд Сираджев Начальник отдела охраны труда, техники безопасности и окружающей среды ГНКАР

Абдул Касымов профессор, член-корреспондент Академии Наук Азербайджана, заведующий лабораторией Института Зоологии, начальник Каспийской биологической станции.

Фаик Аскеров Менеджер отдела охраны окружающей среды БиПи Амоко, профессор Международной Экоэнергетической Академии, кандидат химических наук.

Рафик Касумов профессор, член-корреспондент Академии Наук Азербайджана, заведующий лабораторией Института Физиологии.

Юлий Зайцев Специалист по охране окружающей среды БиПи Амоко

Бахтияр Мурадов Координатор Каспийской экологической программы, представитель Государственного комитета по экологии и рациональному использованию природных ресурсов.

Феган Алиев президент Международной Экоэнергетической Академии, партнер Каспийской экологической лаборатории, созданной БиПи Амоко.

Participants:

Ali Abdullayev Deputy Director for Research on Environmental Protection, "Azgipromerneftegas" Institute, Candidate of Technical Sciences

Agamahmud Sirajev Head of the Environmental Protection, Labor and Safety Department, SOCAR

Abdul Kasymov Professor, Corresponding Member of the Azerbaijan Academy of Sciences, Department Head at the Academy of Sciences' Zoological Institute and Chief of the Caspian Biological Station

Faik Askerov Environmental Manager, BP Amoco, Professor of International Ecoenergy Academy, Ph.D. (Chemistry)

Rafig Kasumov Professor, Corresponding Member of the Azerbaijan Academy of Sciences, Department Head at the Institute of Physiology

Yuliy Zaytsev Environmentalist, BP Amoco

Bakhtiyar Muradov National Coordinator for the Caspian Environmental Program, Representative of the State Committee for Ecology and Control over the Use of Natural Resources

Fegan Aliyev President of International Ecoenergy Academy, Company representative at the Caspian Environmental Laboratory founded by BP Amoco.

Международный нефтяной контракт, заключенный в сентябре 1994 года между Государственной нефтяной компанией Азербайджанской Республики и 11 иностранными нефтяными компаниями из 7 стран, с момента подписания названный "Контрактом века" из-за своего исторического значения, в короткие сроки стал реальностью. Два года назад - в ноябре 1997 г., Гейдар Алиев, Президент Азербайджанской Республики и основоположник новой нефтяной эры на Каспии, торжественно объявил миру о добыче первой Азербайджанской нефти с платформы Чыраг, расположенной на Контрактной площади. В настоящее время, в рамках Контракта Века, с платформы Чыраг ежедневно добывается и экспортируется на мировые рынки свыше 110.000 баррелей нефти.

За последние пять лет в Азербайджане была создана надежная инфраструктура нефтяной промышленности, отвечающая всем международным стандартам. Были реконструированы и введены в эксплуатацию буровые установки "Деде Горгуд" и "Истиглал", платформа Чираг-1, проведена сейсморазведка и пробурены оценочные скважины, проложены подводные трубопроводы для транспортировки сырой нефти, добытой на Контрактной площади, а также попутного газа, безвозмездно передаваемого азербайджанской стороне. Были построены Сангачальский и Супсинский терминалы, полностью отремонтирован Северный трубопровод, и построен новый Западный трубопровод, а также сданы в эксплуатацию другие важные объекты. Таким образом, компания БиПи Амоко, которая является оператором Контракта века, внесла свой вклад в самый крупный созидательный проект в современной истории Азербайджана.

The international oil contract signed in September 1994 between the Azerbaijan State Oil Company and 11 foreign oil companies representing 7 countries and called since the day it was signed the "Contract of the Century" due to its historic significance soon became a reality. Two years ago - in November 1997 Heydar Aliyev, the President of the Azerbaijan Republic and Chief Architect of the Caspian's new oil era, inaugurated and announced to the world the production of the first Azerbaijan oil from the Chirag platform in the Contract Area. At present more than 110,000 barrels of oil produced from the Chirag platform under the Contract of the Century are transported to world markets every day.

A strong oil industry infrastructure meeting all international standards has been created in Azerbaijan over the last 5 years. The Dede Gorgud and Istiglal drilling rigs and Chirag-1 offshore platform were upgraded and commissioned, offshore seismic surveys were completed and appraisal wells were drilled, subsea pipelines were laid for transportation of crude oil produced in the Contract Area and for produced gas cost free for Azerbaijan. The Sangachal and Supsa terminals were constructed, the Northern Pipeline was renovated, a new Western Pipeline was constructed and other important facilities were put into operation. Thus, BP Amoco, the operator of the Contract of Century, set its name to a major originative process in the modern history of Azerbaijan.

As the number of oil contracts increases, so increases the concern about environmental protection. We think, how the work that is being performed or is to be performed under these oil contracts will affect the environment — the air we breathe, the water we drink, the earth we walk on, the ecology of the Caspian, everyone's health and the health of

FEGAN ALIYEV *YULIY ZAYTSEV* *FAIK ASKEROV*
ФАГАН АЛИЕВ *ЮЛИЙ ЗАЙЦЕВ* *ФАИК АСКЕРОВ*

По мере увеличения числа нефтяных контрактов, всех очень беспокоят вопросы охраны окружающей среды. Мы думаем о том, как та работа, которую мы выполняем, или которую нам еще предстоит выполнить в рамках этих нефтяных контрактов, отразится на окружающей нас среде - на воздухе, которым мы дышим, воде, которую мы пьем, земле, по которой мы ходим, экологии Каспия, нашем здоровье и здоровье следующих поколений? Если воздействий избежать невозможно, то как можно их снизить? Какие обязанности и обязательства возложило Азербайджанское правительство на иностранные нефтяные компании при заключении этих нефтяных контрактов? Как выполняются в настоящее время эти обязанности и обязательства? Как контролируется их выполнение? С этой целью несколько хорошо известных азербайджанских ученых и экспертов, работающих в этой области наряду с представителями компании БиПи Амоко поделятся своими мыслями по данным вопросам. Почему именно БиПи Амоко? Во-первых, компания БиПи Амоко является исполнителем, или выражаясь современным языком, оператором 4 из 20 нефтяных контрактов, заключенных в Азербайджане. Помимо этого, БиПи Амоко является единственной компанией, добывающей нефть на Каспии, транспортирующей ее на берег и экспортирующей на мировые рынки по территории Азербайджана.

ФАИК АСКЕРОВ: БиПи Амоко добывает нефть и газ во многих странах мира. Компания начала работать в Азербайджане в 1994 г. Независимо от того, в какой стране мира компания работает, ее политика по вопросам Охраны Здоровья, Техники Безопасности и Охране Окружающей Среды неизменна по всему миру. Главный смысл

future generations. If these effects are inescapable, how can they be reduced? What obligations and duties did the Azerbaijan Government charge foreign companies with when these oil contracts were concluded? How are these obligations and duties being met now? How are they being monitored? With these purposes, several well-known Azerbaijani scientists and specialists working in this field along with representatives of BP Amoco will express their views and ideas in these areas. Why BP Amoco? First, BP Amoco is the executor or, to put it with modern terminology, the operator of 4 of the 20 oil contracts operating in Azerbaijan. BP Amoco is also the sole company producing oil in the Caspian, transporting it onshore and exporting it to world markets through Azerbaijan.

FAIK ASKEROV: BP Amoco is a company that produces oil and gas in a number of countries of the world. The company started working in Azerbaijan in 1994. Regardless of the country where it operates, the company has the same Health, Safety and Environment policy anywhere in the world. The essence of this policy is to work safely and do no harm to people or the environment. our company has been guided by these principles in Azerbaijan. Prior to any work, we have always conducted a baseline environmental study in the Contract Area, as well as generally anywhere we work. This helps us get to know the conditions in the area before we start work. And of course, prior to any project, we develop an EIA (Environmental Impact Assessment) document which shows the possible environmental impact of our activities and how we can reduce this impact. We have performed well in this area so far, and today about 10 EIA documents have been developed and approved by the State Committee on Ecology of Azerbaijan.

FAIK ASKEROV
ФАИК АСКЕРОВ

этой политики заключается в том, чтобы работать с соблюдением норм безопасности, не нанося ущерба людям или окружающей среде. При осуществлении своей деятельности в Азербайджане, наша компания руководствуется именно этими принципами. Прежде, чем приступить к каким-либо работам, мы всегда с начала проводим изучение первоначального состояния окружающей среды как на Контрактной площади, так и в любом другом месте, где мы работаем. Это помогает нам ознакомиться с исходными условиями данной местности до начала выполнения наших работ. И, конечно, до начала каждого проекта, мы готовим документ ОВОС (Оценка Воздействия на Окружающую Среду) в котором рассматриваются возможные воздействия нашей деятельности на окружающую среду и предлагаются методы снижения этого воздействия. Мы достигли больших успехов в этом направлении, и, вплоть до настоящего времени, было подготовлено и утверждено в Госкомэкологии Азербайджана около 10 документов ОВОС.

Of course, there are unavoidable impacts on the environment during the work. And we always have to control these impacts. To do this we conduct environmental monitoring. Monitoring includes the study of fish, seals, birds and other flora and fauna, supervision of the water chemistry, monitoring of the emissions within the Contract Area, i.e. the area on which we operate.

I would like to note that we have always tried to also monitor archeological explorations during construction and repair of both the Northern and Western Export Pipelines. The late Professor Rashid Goyushov had great success in this field, and his. archeological findings have all been registered and covered in his book "**The Archeology of Azerbaijan**". I would like to note that BP Amoco's activities are performed by their experienced international staff. Our company also tries to use environmental consulting companies recognized worldwide. Therefore, companies like ERT, Dames and Moore, Woodward Clide are working together with us. However, I would like to note that all this work could not have been successful without the scientists and specialists of Azerbaijan. Therefore, we always try to use the potential of Azerbaijan science and build and base our performance on it.

I should also emphasize that one of the issues our company is especially attentive to is to inform and provide the population of Azerbaijan, the community with clear information about what we are doing. I would like to bring one more issue to your attention — that Azerbaijan needs oil today. But we also need a clean environment for Azerbaijan's future, for posterity, and for us all. There is a need to achieve this balance. This, to my mind, is possible through joint work. We have to accomplish this in close cooperation with Azerbaijan's regulatory agencies, non-governmental organizations and the oil companies operating in Azerbaijan.

The results I mentioned - ecological achievements could not have been possible without the help of Azerbaijan scientists. Today our company has a mechanism by which we involve Azerbaijan's scientists and organizations in this work. This mechanism includes the Ecological Subcommittee, established under the Contract and its working groups for research and monitoring. These Subcommittee and Working Groups include representatives from SOCAR, State Committee on Ecology, Academy of Sciences and "Gipromorneftegas" Institute.

ALI ABDULLAYEV: The history of founding the Working Groups and the Environmental Sub-committee dates back to 1992. When a memorandum on the three fields - Azeri, Chirag, Guneshli, was prepared in May-June of 1993, our specialists suggested that an ecological strategy for the development of these three fields be specifically given therein - it had been developed by our specialists. The strategy contained a suggestion on the creation of said Subcommittee and Working Groups. These

Конечно, существуют неизбежные воздействия нашей деятельности на окружающую среду. И нам необходимо постоянно контролировать эти воздействия. С этой целью мы проводим экологический мониторинг. Он включает наблюдение за рыбами, тюленями, птицами и другими представителями флоры и фауны, наблюдение за состоянием водной химии, выбросами в атмосферу в пределах Контрактной площади, т.е той части Каспийского моря, на которой мы осуществляем свои работы.

Хотелось бы отметить, что в ходе осуществления строительных и ремонтных работ на Северном и Западном экспортных трубопроводах, мы всегда старались проводить так же и археологические исследования. Покойный профессор Рашид Геюшев достиг значительных успехов в этой области, и все результаты его археологических изысканий были зарегистрированы и рассматриваются в книге "Археология Азербайджана".

Я хотел бы отметить, что для выполнения работ компания БиПи Амоко использует ее опытный международный персонал. Наша Компания так же старается использовать услуги всемирно признанных консалтинговых экологических фирм. Именно поэтому вместе с нами работают такие компании, как ERT, Dames & Moore и Woodward Clide. Но при этом, необходимо отметить, что вся эта работа не была бы такой успешной без участия азербайджанских ученых и специалистов. Исходя из этого, мы всегда стараемся использовать азербайджанский научный потенциал, опираясь на него в нашей работе.

Я хотел бы еще отметить, что наша компания уделяет особое внимание вопросу информирования и снабжения населения и общественности Азербайджана четкими сведениями о том, что мы делаем. Хотелось бы особо отметить еще одно обстоятельство - нефть нужна Азербайджану сегодня. Однако, чистая экология нужна всем нам, для будущего Азербайджана, для будущих поколений. Нам необходимо установить соответствующий баланс. Это, по-моему, возможно только совместными усилиями. Мы должны достичь этой цели, работая в тесном сотрудничестве с азербайджанскими регулирующими органами и неправительственными организациями, а также другими нефтяными компаниями, работающими в Азербайджане.

Результаты, о которых я говорил, экологические достижения - были бы невозможны без помощи Азербайджанских ученых. Сегодня в нашей компании существует механизм привлечения к нашей работе азербайджанских ученых и организаций. Этот механизм включает создание в рамках нефтяного контракта экологического подкомитета, его рабочих групп по научным исследованиям и мониторингу. В данный

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recommendations were accepted on September 20, 1994 when the Contract of the Century was signed.

ABDUL KASIMOV: BP Amoco has developed a Strategic Monitoring Program. Both Azerbaijan and foreign scientists took part in developing this Program. So far, i.e. since 1995, annual monitoring has been carried out in the Contract Area, i.e., the Chirag field and vicinity. In addition, extensive monitoring work has been done with birds, seals, birds and in other areas at Sangachal terminal. The primary goal of the surveys was to prevent environmental pollution. The surveys show that sea water remains nearly uncontaminated as a result of the use of new technology at the Chirag platform. Sea bed sedimentation, hydrocarbons, heavy metals and sea bed fauna are also studied in detail during such monitorings. It was concluded from the surveys that at present there is no negative impact on the marine organisms. Their condition is as it was before drilling and no major changes have been observed. Besides, monitoring has been done on the Northern Pipeline and also on the quantitative distribution of birds and migration of seals along Azerbaijan's shores. The results of the surveys were submitted to the

подкомитет и Рабочие группы входят представители ГНКАР, Госкомэкологии, Академии Наук и института "Гипроморнефтегаз".

АЛИ АБДУЛЛАЕВ: История создания Рабочих Групп и Экологического подкомитета начинается в 1992 г. В мае-июне 1993 г., при подготовке меморандума о разработке трех месторождений Азери-Чираг-Гюнешли, наши ученые предложили включить в него специальный раздел об экологической стратегии разработки этих месторождений, который был подготовлен нашими специалистами. Стратегия предусматривала создание указанного Подкомитета и рабочих Групп. Эти рекомендации были приняты 20 сентября 1994 г. при подписании Контракта века.

АБДУЛ ГАСЫМОВ: Компания БиПи Амоко разработала Стратегическую программу мониторинга. В разработке этой Программы принимали участие как азербайджанские, так и иностранные ученые. С 1995 г. по сей день на Контрактной площади, то есть на месторождении Чираг и вокруг него, проводятся ежегодные мониторинги. Помимо этого, обширная программа мониторинга птиц, тюленей, рыб и других компонентов, проводилась в районе Сангачальского терминала. Цель этих исследований заключается в том, чтобы предупредить загрязнение окружающей среды. Результаты исследований показали, что благодаря использованию на платформе Чираг новых технологий, морская вода остается практически незагрязненной. Во время данных мониторингов так же тщательно изучаются донные осадки, содержание углеводородов, а также фауна морского дна. В результате исследований было вынесено заключение, что в настоящее время не существует никакого отрицательного воздействия на морские организмы. Их состояние почти такое же, как было до начала буровых работ; никаких значительный изменений обнаружено не было. Помимо этого, проводился мониторинг с целью изучения количественного распределения птиц вдоль азербайджанского берега и миграции тюленей вдоль побережья Азербайджана, а также мониторинг трассы Северного трубопровода. Результаты исследований были представлены в Отдел охраны окружающей среды, в котором была спланирована и реализована необходимая работа.

В проведении этих исследований принимают участие английские специалисты, азербайджанские ученые, представители Государственного комитета по экологии, а также эксперты, работающие в этой области. Они проводят обширные изыскания, результаты которых представляются в Государственный комитет по экологии, на основании которых впоследствии проведятся некоторые другие исследования.

ABDUL KASIMOV
АБДУЛ ГАСЫМОВ

Ecological Department, where necessary work was planned and completed.

English specialists, Azerbaijan scientists, the State Committee for Ecology and experts in this field are involved in these surveys. They conduct extensive surveys, the results of these surveys are presented to the State Committee for Ecology, and some other extensive surveys are performed on their basis.

FAIK ASKEROV: Abdul Kasymov talked about monitoring and gave some information about seals. I would like to touch upon the issue of the seal deaths frequently reported in the Azerbaijan media, most often linked to the activities of oil companies. But I would like to remark that we were aware of it as far back as 1997 — before our company was producing oil. Therefore, we organized research on seals which was carried out under Professor Demir Hajiyev and Tariyel Heybatov with Suzanne Wilson, a World Bank representative supervision. The research showed that the seal deaths were not caused by oil and oil products, but by the viruses in their bodies and chemicals like DDT.

FEGAN ALIYEV
ФАГАН АЛИЕВ

ФАИК АСКЕРОВ: Абдул Гасимов говорил о мониторинге и дал некоторую информацию о тюленях. Я хотел бы затронуть вопрос о смертности тюленей, сообщения о которой часто встречаются в азербайджанских средствах массовой информации, что зачастую связывают с деятельностью нефтяных компаний. Однако, следует отметить, что об этом было известно еще в 1997 г., то есть до того, как наша Компания начала добычу своей нефти. В связи с этим мы организовали исследования по тюленям, которые проводились под руководством профессора Дамира Гаджиева, Тариэля Гейбатова и Сьюзан Уилсон, представителя Всемирного Банка. Исследования показали, что смертность тюленей была вызвана не нефтью и нефтепродуктами, а наличием вируса в их телах и химикатов вроде DDT.

РАФИК КАСУМОВ: Результаты исследований российских, японских и азербайджанских ученых, включая те исследования, которые проводились до 1999 г., были объявлены на рабочем заседании Каспийского Координационного Совета.

RAFIG KASUMOV: The results of the research, even the research carried out up to 1999 by Russian, Japanese and Azerbaijan scientists, were announced at a workshop led by the Caspian Coordination Council. It was clear that oil products had nothing to do with the deaths of the seals. Very good results were announced at the workshop, and it was in fact proven that the reason for the deaths of the seals, as you put it, is mainly a virus disease. Therefore, the spreading of misinformation about the impact of oil is totally wrong.

AGAMAHMUD SIRAJEV: Abdul Kasymov talked about monitoring in detail, but I would like to add some points. In addition, algae were monitored near Sangachal terminal to study the impact of oil and gas production processes on the environment. Rock samples were also taken from the drilled appraisal wells later to study their direct impact on the environment. Samples of sea bed sediments were taken, their physical and chemical analysis once more showed that the environmental impact is really negligible. No essential changes were seen relative to the requirements of water quality standards.

FEGAN ALIYEV: As a logical continuation of what has been said I would like to add that Volga, discharges from Volga and previously the industrial enterprises of Sumgayit are playing the major role in the pollution of the Caspian. Eighty percent of the wastes flowing into Caspian were discharged from industrial enterprises located along Volga. After the shutdown of the majority of chemical enterprises in recent times, the Caspian became considerably healthier.

YULIY ZAYTSEV: Our group pays a great attention to carrying out of environmental monitoring, and we, the members of our group, conduct this work and meet daily. And at the beginning of each year we develop new programs for conducting environmental monitoring at various facilities of our company, including Chirag-1 platform, Sangachal terminal and the routes of the Northern and Western Export Pipelines. In particular, the members of our working group visit all these facilities regularly. They assess the impact of our activities on the environment, give their recommendations and suggest measures, that should be taken to minimize the environmental impact. In particular, our company pays great attention to the waste management issue. Waste management issues are always very important for the environmental safety. The goal of our company is to cause no damage to the environment. And it would be impossible to achieve this goal if we didn't pay due attention to this matter. Our concept of the waste management is to trace all waste streams "from cradle to death". With this aim we are cooperating with leading research institutes of the Academy of Sciences, involve the services of Caspian Ecological Laboratory, which help us identify environmentally acceptable techniques for certain hazardous waste reclamation. The waste reclamation for their further re-use is our priority.

Очевидно, что нефтепродукты не имеют никакого отношения к смерти тюленей. На рабочем заседании были объявлены очень хорошие результаты, и было доказано, что причиной смерти тюленей, в основном, является вирусная болезнь. Таким образом, распространенная информация о нефтяном воздействии была совершено неверной.

АГАМАХМУД СИРАДЖЕВ: Абдул Касымов подробно рассказал нам о мониторинге, однако я хотел бы кое-что добавить. Помимо прочего, был проведен мониторинг водорослей в районе Сангачальского терминала с целью изучения воздействия процесса добычи нефти и газа на окружающую среду. Позднее, из пробуренных оценочных скважин были отобраны пробы пород для изучения их прямого воздействия на окружающую среду. Также были взяты пробы отложений придонного слоя, и был проведен их физико-химический анализ, результаты которого еще раз подтвердили, что воздействие на окружающую среду незначительно. Не было отмечено каких-либо существенных отклонений от нормативных характеристик морской среды.

ФЕГАН АЛИЕВ: В продолжении этой темы я хотел бы добавить, что Волга, сбросы с Волги, а также в недавнем прошлом промышленные предприятия Сумгаита играют самую большую роль в загрязнении Каспия. Восемьдесят процентов отходов, втекающих в Каспий, сбрасываются промышленными предприятиями, расположенными вдоль реки Волга. После остановки работы большинства химических предприятий, Каспий стал значительно чище.

ЮЛИЙ ЗАЙЦЕВ: Наша группа уделяет очень большое внимание проведению экологического мониторинга и на повседневной основе мы проводим данную работу и заседания нашей группы. В начале каждого года мы разрабатываем новые программы проведения экологического мониторинга на различных объектах нашей компании, в частности на платформе Чираг-1, на Сангачальском терминале, а также вдоль трасс северного и западного маршрута экспортных трубопроводов. В частности, члены наших рабочих групп на периодической основе посещают все эти объекты. Они проводят оценку воздействия нашей деятельности на окружающую среду.

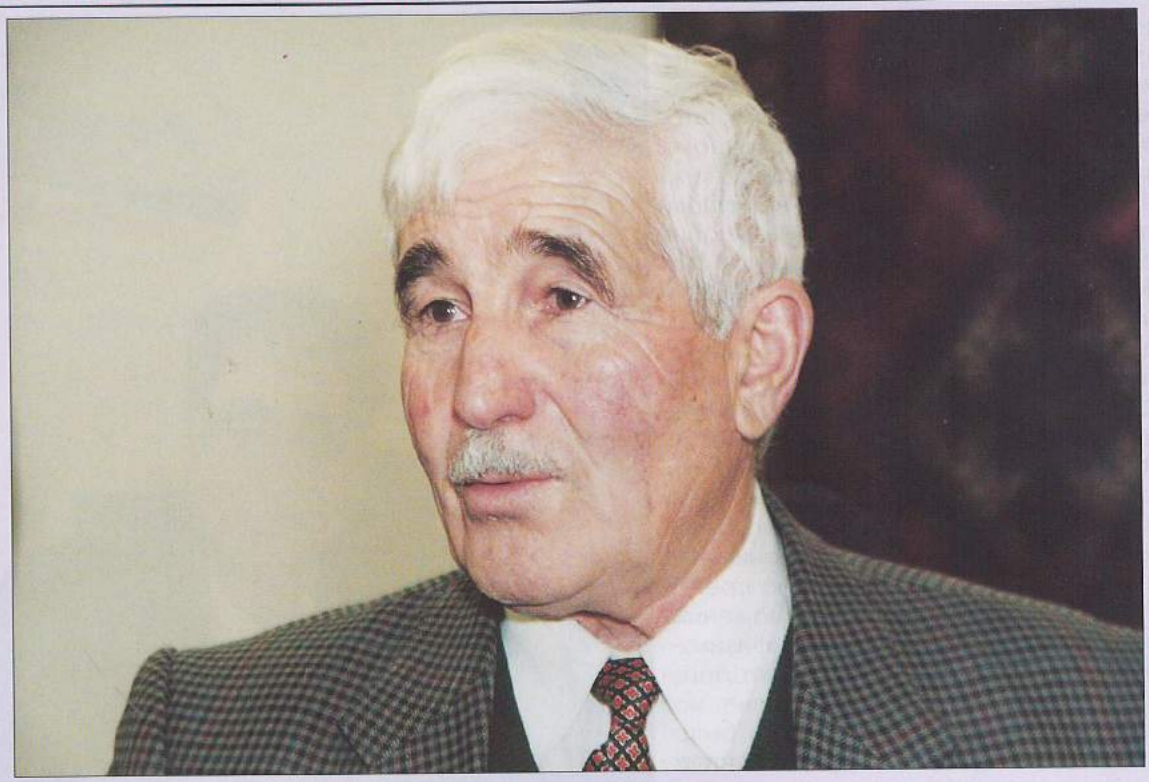
В частности, наша компания очень большое внимание уделяет вопросу управления отходами. Вопросы управления отходами всегда являются актуальными с точки зрения экологической безопасности. И цель нашей компании заключается в том, чтобы не нанести ущерб окружающей среде. И достичь ее было бы невозможно, если бы мы не уделяли этому должного внимания. Наша концепция по управлению отходами заключается в том, чтобы следить за всеми их потоками "от рождения до смерти". С этой целью мы сотрудничаем с нашими

AGAMAHMUD SIRAJEV

АГАМАХМУД СИРАДЖЕВ

I would also like to mention those visits that are made by the members of our group to our company's facilities. Recently we, together with the members of the working group, have visited the Chirag platform, Sangachal terminal, Sangachal landfill for hazardous wastes and Operational Supply Base of BP Amoco.

ALI ABDULLAYEV: Technological monitoring is a very important operation. I first visited the Chirag platform together with the former Environmental Manager Liz Rogers on January 12, 1998; for the second time — with environmentalist Yuliy Zaytsev — on December 1, 1998. Well No. 3 was being drilled from the Chirag platform when we came there for the first time. During our second visit we completely investigated all technological processes on platform. At the time well No 8 was being drilled from the platform. During our first visit certain operations at variance with standards were discovered at some places. We brought them to the producers' attention. The shortcomings we first noted were eliminated when we came there for the second time. What do we



RAFIG KASUMOV
РАФИК КАСУМОВ

ведущими научными институтами Академии Наук, пользуемся услугами Каспийской Экологической Лаборатории, которые помогают нам найти экологически приемлемые методы по утилизации тех или иных опасных отходов. Дело в том, что утилизация отходов с целью их повторного использования наша приоритетная задача.

Я еще хотел бы остановиться на тех визитах, которые совершают члены нашей группы на объекты нашей компании. За последнее время мы вместе с членами рабочей группы посетили платформу Чираг, Сангачальский терминал, Сангачальский полигон по захоронению опасных отходов и Операционную базу снабжения компании БиПи Амоко.

АЛИ АБДУЛЛАЕВ: Технологический мониторинг это очень важное мероприятие. Впервые я посетил платформу Чираг-1 вместе с бывшим менеджером по Экологии Лиз Роджерс 12 января 1998 г.; во второй раз - со специалистом по экологии Юлием Зайцевым 1 декабря 1998 г. Во время нашего первого визита на платформе Чираг-1 бурилась скважина № 3. Во время второго посещения мы полностью изучили все технологические процессы на платформе, и в то время шло бурение скважины № 8. В первый раз некоторых случаях мы обнаружили, что определенные работы выполнялись с отклонением от стандартов. Мы привлекли внимание операторов к этим отклонениям. Недостатки, замеченные нами во время первого посещения, были устранены к моменту нашего второго визита. С чем мы сравниваем эти данные? Мы сравниваем их с проектами и презентациями, данными нам во время обсуждений.

compare these data with? We compare them with the projects and presentations given to us during the discussions.

AGAMAHMUD SIRAJEV: Taking into account that the management of ecological problems is one of the significant components of the management of oil and gas production operations as a whole, SOCAR had put this question rather earnestly to foreign oil companies when negotiations on the oil contracts were still going on. This is precisely why BP Amoco and the other foreign companies in the consortium for the developments under the "Contract of the Century", made serious commitments to protect the environment. Everything is clear from the speakers' reports, and I also can support them and state unconditionally that these commitments are mainly met. In some cases the members of our Subcommittee and other scientists and experts of our Republic even came up with proposals in addition to those provided for in the Contract. Most of these proposals are accepted after BP Amoco carefully studies them.

I would simply like to underline one fact — the experts of our Republic proposed changing the pipeline route in the Agstafa District when the draft project for the Western Route Oil Pipeline was being developed. BP Amoco gladly accepted this proposal. Considering the potential impact of produced water to be discharged into the sea on the flora and fauna of the sea, members of our group and I personally raised the question of and submitted our recommendations on reinjecting produced water into the underground horizons. It has generally been agreed that these issues will be considered in future after they have been carefully studied by the company's Environmental Department and other experts.

АГАМАХМУД СИРАДЖЕВ: Принимая во внимание, что управление экологическими вопросами является одним из существенных компонентов управления работами по добыче нефти и газа в целом, ГНКАР открыто поставила этот вопрос на обсуждение с представителями иностранных нефтяных компаний во время проведения переговоров по заключению нефтных контрактов. Именно поэтому, БиПи Амоко и другие иностранные компании - участники консорциума по разработке "Контракта Века", взяли на себя серьезные обязательства в отношении охраны окружающей среды. Как явствует из заявлений участников нашего круглого стола, к которым я присоединяюсь, можно безусловно сказать, что эти обязательства были, в основном, выполнены. В некоторых случаях, члены нашего Подкомитета и другие ученые и эксперты нашей Республики даже выдвигали предложения в дополнение к тем, что были описаны в условиях Контракта. Большинство этих предложений после их тщательного рассмотрения принимаются компанией БиПи Амоко.

Я бы хотел отметить один факт - эксперты нашей Республики предложили изменить маршрут трубопровода в районе Акстафы при подготовке предварительного проекта Западного маршрута экспортного трубопровода. БиПи Амоко с готовностью приняла это предложение. Рассматривая потенциальное воздействие сбрасываемых в море пластовых вод на морскую флору и фауну, члены нашей группы, и я лично, подняли вопрос и предложили свои рекомендации по обратной закачке пластовых вод в подземные горизонты. Было принято решение о том, что эти вопросы будут рассмотрены в будущем, после тщательного изучения со стороны представителей отдела Экологии компании и других экспертов. Точно также происходило и в случаях с другими проектами. Мы с чрезвычайной серьезностью относимся ко всем вопросам. Принимаются во внимание мнения ученых и экспертов Республики. Более того, я хотел бы воспользоваться этой возможностью и привлечь внимание общественности к следующему. Иногда в местной прессе встречаются заявления, далекие от истины и преувеличивающие воздействие на окружающую среду операций по добыче нефти и газа. Несмотря то, что эти вопросы обсуждались, в последнее время общественности было сообщено о гибели большого количества птиц на некоторых островах. Дело в том, что эта информация беспочвенна. В результате инспекции было выявлено, что на островах Занбиль и Гиль погибли соответственно 10 и 17 птиц, однако ни одна из них не погибла в результате нефтяного загрязнения. Я бы хотел еще раз попросить, чтобы при распространении подобной информации, люди основывались бы на фактах, поскольку нефть играет большое значение в экономическом и политическом благосостоянии нашего народа, а распространение дезинформации может отрицательно сказаться на выполнении этих соглашений.

YULIY ZAYTSEV

ЮЛИЙ ЗАЙЦЕВ

This has been the case with other projects as well. We take all issues very seriously. Careful consideration is given to the opinions of the Republic's scientists and experts. In spite of all this, I would like to take this opportunity and draw the public attention to one fact. Sometimes we encounter statements in the national press that are far from reality and exaggerate the environmental impact of oil and gas production. Despite the fact that these cases have been discussed, the public is being told that a great number of birds have lately died on some islands. However, this information is groundless. The inspection indicated that 10 and 17 birds died on the Zanbil and Gil Islands, but none died as a result of oil pollution. I would like to ask once again that people refer to the facts when such information is spread, because the oil contracts are for our national economic and political benefit and misinformation may to a certain extent negatively affect the implementation of these contracts.

I am hardly claiming that the oil and gas production industry will not affect the environment. It has

Я не хочу сказать, что добыча нефти и газа не окажет никакого воздействия на окружающую среду. Воздействия на окружающую среду есть, но мы должны предупредить или сократить их, и такие шаги предпринимаются.

БиПи Амоко, до начала своей деятельности, разработала конкретную программу по предотвращению нефтяных разливов. В этой программе описываются процедуры аварийного реагирования в случае потенциальных аварий. Компания, которая называется "Бриггз Марин" оснащена всем необходимым оборудованием. Я лично ознакомился с их работой во время аварии на Северном маршруте экспортного трубопровода. Они очистили почву, восстановив ее первоначальное состояние.

РАФИК КАСУМОВ: Я хотел бы еще раз упомянуть прошедшее недавно совместное рабочее заседание прикаспийских стран. На этом заседании, российские ученые отмечали, что смерть птиц, пролетающих над Каспийским морем, в большинстве случаев связана с отравлением в Северном Каспии веществом под названием сульфатный ангидрид. Они пришли к этому заключению в результате проведенных исследований. Обсуждая эту тему, я также хотел бы отметить, что БиПи Амоко уделяет этим вопросам большое внимание. В частности, наша исследовательская группа со всей серьезностью относится к этим вопросам. При возникновения какого-либо вопроса в нашей исследовательской группе, мы немедленно приступаем к его обсуждению. Если вопрос серьезный, мы представляем в БиПи Амоко рекомендацию с предложением его изучения. Если, по нашему мнению, необходимо исследование какого-либо вопроса, мы даем компании информацию о том азербайджанском исследовательском институте, который мог бы провести подобные изыскания.

Хотелось бы привлечь ваше внимание еще к одному вопросу. Мои коллеги не должны думать, что каждый может делать то, что он хочет. Каспийское море является уникальным водоемом. Даже когда международные компании захотели применять в отношении Каспийского моря стандарты, разработанные для Северного Моря или Мексиканского Залива, мы категорически заявили, что это невозможно, и убедили их в том, что необходимо разработать стандарты конкретно для Каспийского моря. Мы предложили подготовку таких процедур со стороны азербайджанских ученых. Мы выяснили их мнение и, на основании этих мнений, совместно с английскими учеными подготовили соответствующие процедуры. Этот документ получил название - Каспийские Специфические Экотоксикологические процедуры. Мы обсуждали эти процедуры несколько раз. После разработки, они были переданы в Комитет по экологии и были одобрены им.

Далее, после определенных консультаций, члены нашей группы пришли к решению о необходимости образования специальной лаборатории, которая бы занималась изучением токсикологии. Мы знаем, что в Азербайджане

an environmental impact, which must be prevented or minimized, and these steps are being taken.

BP Amoco developed a specific program for preventing oil spills before it started operating. This program detailed emergency response procedures for potential accidents. A company called Briggs Marine has all necessary equipment. I personally familiarized myself with their work during the accident on the Northern Route Oil Pipeline. They cleaned the soil and returned it to its initial state.

RAFIG KASUMOV: I would like to once again talk about the recent joint workshop of the Caspian countries. Russian scientists there noted that the death of birds flying over the Caspian Sea in most cases results from poisoning in the North Caspian with a substance called sulphate-antigorite. They came to this conclusion as a result of investigations. While we are on the topic, I would like to stress that BP Amoco also pays a great deal of attention to these issues. In particular our research group pays as much attention to these problems as possible. If a question arises in our research group, we start discussing that question without delay. If the question is important, we submit a proposal to BP Amoco that this question be investigated. If we consider the investigation of any question necessary, we advise the company of the Azerbaijan research institute that can investigate this question.

I want to emphasize one more thing. My colleagues must not think that anybody may do whatever he wants here. The Caspian Sea is a unique body of water. Even when international companies wanted to transfer the standards developed for the North Sea or the Gulf of Mexico to the Caspian Sea, we flatly said that it was impossible and that specific standards must be prepared for the Caspian Sea. We suggested that Azerbaijan scientists prepare these standards. We learned their opinions and, on the basis of these opinions, we prepared procedures together with the English scientists. They are called the Caspian Specific Ecotoxicological Procedures. We discussed them several times. In the end they were submitted and approved by the Ecology Committee.

Furthermore, upon consultation our group members decided that a special laboratory must be established to investigate toxicology. We know that there are research institutes in Azerbaijan. However, they do not have modern equipment, and consequently the results of studies they perform are not on the international level. Here the main objective is not only to conduct studies. The level of the studies must be on the international level. For that reason a laboratory was established here. The laboratory investigated drilling fluids considered to be used in the Caspian Sea.

We discuss any investigation necessary in any area with our group members and submit proposals to the Environmental Department. This Department recruits foreign scientists to perform the studies if we do not have experts.

The development of Caspian Specific Ecotoxicological Procedures and organization of the

существуют исследовательские институты. Однако, они не располагают современным оборудованием и, следовательно, результаты исследований, проводимых в этих институтах, не отвечают мировым стандартам. Цель образования подобной лаборатории заключается не только в необходимости проведения исследований. Сами исследования должны проводиться на уровне международных стандартов. Для этой цели в Азербайджане была открыта специальная лаборатория. В частности, в этой лаборатории проводились анализы буровых растворов, которые рассматривались для использования в Каспийском море.

Члены нашей группы обсуждают необходимость проведения конкретных исследований в той или иной области и представляют свои предложения на рассмотрение в Отдел Экологии. В случае, если мы не можем какие-либо исследования собственными силами, данный отдел привлекает иностранных ученых для их проведения.

Разработка Каспийских экотоксикологических процедур и организация Каспийской экологической лаборатории происходили совместно с учеными Азербайджана. Мы хотели бы, чтобы они использовались и в других прикаспийских странах.

После обсуждения данных процедур в нашей компании и членами нашей группы, а также после утверждения в экологическом подкомитете, мы направили их в Государственный комитет по экологии. Процедуры были одобрены в Комитете по экологии.

BAKHTIYAR MURADOV
БАХТИЯР МУРАДОВ

БАХТИЯР МУРАДОВ: Данные Процедуры были одобрены в Государственном комитете по экологии и являются обязательными. Однако, существует одна большая проблема. Мы знаем, что Каспийское море омывает пять стран. Международные спонсоры создали Каспийскую экологическую программу с тем, чтобы руководствоваться унифицированными кодексами, стандартами и процедурами. Основная цель нашей программы заключается в восстановлении разнообразия природы Каспийского моря, управлении прибрежной зоной, снижении уровня загрязнения моря и стабильном развитии. Это довольно долгосрочная программа. Она рассчитана на 8 лет. В течение первых 4 лет ее центр будет в Азербайджане.

Я хотел бы затронуть вопрос о взаимоотношениях между Государственным комитетом по экологии и компанией БиПи Амоко. В начале, конечно, существовали определенные проблемы. Мы не понимали их, они не понимали нас. Мы не принимали их стандартов, и у нас были собственные, довольно жесткие, стандарты, которым мы не следовали. У компании же были

Caspian Environmental Laboratory were conducted with Azerbaijan scientists. We wish that they would be used in the other Caspian countries as well.

We sent them to the national Ecology Committee after they had been discussed in our company and by our group and approved by the Ecological Subcommittee. They were approved by the Committee as well.

BAKHTIYAR MURADOV: These procedures have been approved by the State Committee for Ecology and they are mandatory. However, we have one big problem. You know that the Caspian Sea touches five countries. The international sponsors established the Caspian Environmental Program in order to be guided by unified codes, standards and procedures. The main objective of our program is restoration of diversity in the Caspian Sea, the management of the coastal zone, a reduction in offshore pollution and stable human development. This is a very long-term program. It has been scheduled for 8 years. For the first 4 years the center will be in Azerbaijan.

несколько более свободные требования, но которые они с точностью соблюдали. Ситуация была очень сложная. Однако, теперь, мы пришли к взаимопониманию почти по всем вопросам. Компания поняла наши требования, поняла, что у нас имеются ученые, с которыми она могла бы работать. Мы, со своей стороны, поняли их кодексы, нормативные требования и соглашения. Компания придерживается положений соглашения и, в некоторых случаях старается улучшить показатели, например в отношении положений статьи о "Загрязнении". Я был лично свидетелем случая с саралином; проведение эксперимента по его использованию вызывало недовольство. Профессор Касумов возглавлял оценочную комиссию, и мы поняли, что это недовольство было необоснованным.

ФЕГАН АЛИЕВ: Нефтегазовая промышленность, развивающаяся в настоящее время в Азербайджане, сильно отличается от нефтегазовой промышленности в других прикаспийских странах, и изучается более тщательно. Я говорю это не потому, что я азербайджанец или бакинец. Уровень проводимых исследований и применение западных стандартов в Азербайджане выше, чем в других прикаспийских странах. Я уверен, что проводимые нами исследования и используемые стандарты будут приняты и в других прикаспийских странах. Дело в том, что это просто научные исследования. Это работа, которая осуществляется с помощью наиболее современного оборудования. Наилучшие эксперименты проводятся совместно азербайджанскими и иностранными учеными. Это трудно отрицать. Существуют нормативные документы, которые полностью отвечают стандартам, принятым OSPARCOM. Я рад, что эти нормативные документы и законы разрабатываются в Баку.

Недавно был опубликован 6-ой международный журнал "Энергия, Экология Экономика,". Этот журнал распространяется по всему миру. В нем публикуются работы азербайджанских ученых и экспертов, которые синтезируются с работой западных, российских и американских ученых. Можно сказать, что образуется новое направление в науке. Азербайджанское общество получает важную экологическую информацию, люди узнают о том, что происходит, а ученые получают возможность применить свои идеи на практике - в промышленности. И сами азербайджанские ученые приобретают исследовательский опыт. Результаты экологических исследований, проводимых азербайджанскими учеными успешно передаются международному сообществу так же с помощью проводимых международных конгрессов, семинаров.

РАФИГ КАСУМОВ: Хотелось бы отметить то, что происходит внутри страны, какая работа проводится по повышению экологического образования, как информируется наше общество об этой работе. В течение последнего времени, мы, члены группы, совместно со специалистами Компании БиПи Амоко проводили презентации в

I would like to touch on mutual relations between the State Committee for Ecology and BP Amoco. At the beginning there were, of course, major problems. We did not accept them, and they did not understand us. We did not comprehend their standards, and we had our own rather strict ones which we didn't followed. They had somewhat weaker requirements which however were followed. It was very complicated. Now we are in almost complete agreement with them. They understood what we wanted. They understood that we have scientists who can do the work. We understood that they adhere to all their codes, legislation and agreements. They adhere to and even try to reduce what is written, for example, with respect to Paragraph "Pollution." I have been an eyewitness in connection with saraline, and when he "conducted" an experiment there was a commotion. Professor Kasumov headed this commission and we -understood that this commotion really was irrelevant.

FEGAN ALIYEV: The oil and gas industry now developing in Azerbaijan differs greatly from the one in the Caspian countries and is being studied more carefully. I do not say this because I am an Azerbaijani or Baku-born. The level of studies performed and the application of western standards in Azerbaijan is higher than in any of the Caspian countries. I am sure that the studies we perform and the standards we apply will be accepted by the Caspian countries. The fact is that it is simply scientific research. This is work performed with the latest tools. The best experiments are performed jointly by Azerbaijan and foreign scientists. To deny it is very difficult. These are regulatory documents that fully meet the standards adopted by OSPARCOM. I am very glad that these regulatory documents and the laws are being developed in Baku.

Recently, the 6th international journal "Energy, Economics, Environment" has now been published. This journal is being distributed all over the world. The works of Azerbaijan scientists which are synthesized with those of the Western, Russian and American scientists are published here. We can say that a new direction in science is developing. The Azerbaijan society gains ecologically vital information, and people know what is going on. And researchers get a chance to apply their ideas in industry. Azerbaijan scientists themselves also gain research practice.

The results of ecological research by Azerbaijan scientists are successfully delivered to the international community and with the help of the international congresses, workshops.

RAFIG KASUMOV: I would like to mention the situation in the country, the work, that is being done for increasing of the ecological awareness, the ways of familiarizing the public with this work. During this time the members of the group together with BP Amoco specialists have been giving presentations at secondary schools and publishing articles in newspapers and magazines, both on ecology BP Amoco's ecological policy. For example, a few days ago we visited the ecology lyceum "Araz". There we made a presentation of ecological book for school children

общеобразовательных школах, публиковали статьи в местных газетах и журналах об экологии и об экологической политике БиПи Амоко. Например, я хотел бы рассказать о том, что недавно мы посетили бакинский экологический лицей "Араз". Там мы провели презентацию экологической книги для школьников "Удивительный мир природы Каспийского моря", подготовленной и опубликованной компанией БиПи Амоко. Дети с удовольствием принимали участие в этом мероприятии. Такого рода публикации еще не было ни в одной другой прикаспийской стране. Они представляют собой увлекательную экологическую литературу для наших детей. Школьники были рады присутствовать на встрече и с большим интересом активно участвовали в этом мероприятии.

Общественность с интересом относится ко всем этим вопросам. Люди практически не имеют информации по экологии или работе, проводимой в нефтяной промышленности. В результате отчетов членов нашей группы и других экспертов, общественность постепенно понимает, что компания уделяет экологии большое внимание. Вопросы охраны окружающей среды являются чрезвычайно важными для компании БиПи Амоко, поскольку она работает не только в Азербайджане. Она работает в разных уголках мира, приблизительно в 40 странах. Они говорят: "Ни одна страна не захочет работать с нами, если мы не будем должным образом выполнять свою работу здесь". Поэтому, этой работе уделяется большое внимание, и население Азербайджана понимает, что данная компания действительно очень серьезно относится к вопросам охраны окружающей среды.

ФЕГАН АЛИЕВ: И Азербайджанское научное сообщество должно учитывать экологические факторы в проведении своих научных исследований, научной работы и научного образования. Это новый этап и новое направление.

В заключении, можно сказать, что благодаря работе, выполняемой в рамках Контракта века - одного из крупнейших созидательных проектов в современной истории Азербайджана - в Азербайджане, и в Каспийском регионе в целом, были внедрены новые промышленные технологии и методы и наиболее передовые экологические стандарты, экологические практики и методы экологического образования, признанные в других частях света. Компания БиПи Амоко успешно сотрудничает с азербайджанскими учеными и с местными экспертами с целью адаптации этих стандартов к условиям Каспийского моря, являющегося уникальным водоемом. Проводимая исследовательская и мониторинговая работа приносит большие результаты.

"Wonderful Wildlife of the Caspian Sea" prepared and published by BP Amoco. Children eagerly took part in this event. Such books have not yet been published in any Caspian country. These books are wonderful ecological literature for our children. The children were pleased to attend this meeting and actively participated in this event.

Actually the public hears about these issues with great pleasure. The community had almost no information on ecology or the work done by the oil industry. As a result of reports by our group members and other experts, the community gradually became aware that these companies pay a great deal of attention to ecology. Environmental protection is extremely important for BP Amoco because they do not operate only in Azerbaijan. They operate in various corners of the world, in approximately 40 countries. They say that no other country will welcome us if we do not do our work here as required. Therefore, they pay a very great deal of attention to this work, and the population of Azerbaijan understands full well that this company really is rather sensitive to the environment.

FEGAN ALIYEV: And Azerbaijan's scientific community must take into account the ecological aspects in its own research and scientific education. This is a new phase and a new direction.

In conclusion, we can say that because of work performed under the Contract of the Century — one of the greatest creative pages in Azerbaijan's modern history — new oil industry technology and techniques and the most advanced environmental standards, ecological practices and ecological education proven in other parts of the world are coming to Azerbaijan and the Caspian Region as a whole. And BP Amoco is effectively cooperating with Azerbaijan scientists and local experts on adapting these standards to the Caspian Sea, a unique body of water. The research and monitoring they jointly perform are yielding efficient results.

Material have been prepared by

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Материал подготовлен

Айбениз Аскеровой, МЭА

International Ecoenergy Academy has received numerous references concerning a paper "Perspectives from research on the environmental effects of offshore discharges of drilling fluids and cuttings published in the fifth issue of scientific-popular journal "Energy, Ecology, Economy. Editorial board thanks the authors - J.P. Smith, R.C. Ayers and R. D. Tait for providing the journal with such interesting material. Considering readers' interest in the environmental problems of offshore oil and gas production we are publishing more extended variant of the paper.

Perspectives From Research on the Environmental Effects of Offshore Discharges of Drilling Fluids and Cuttings

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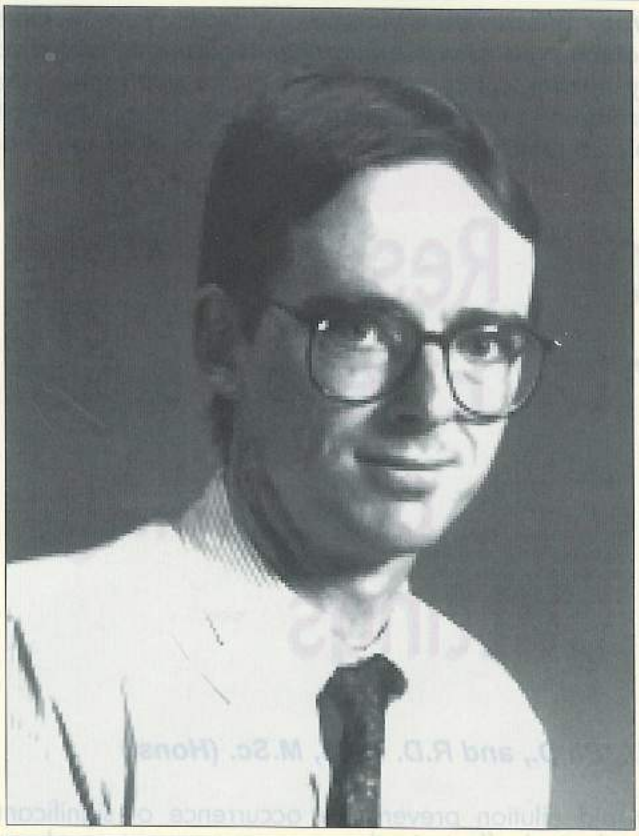
Abstract

Scientific research conducted over the last twenty years has addressed concerns about the potential effects of the offshore discharge of waste drilling fluids and cuttings. Based on consideration of both the results of research and the benefits of offshore oil and gas production, many countries have determined that discharges of drilling wastes are permissible under certain conditions. Extensive environmental research provides a sound scientific basis for these regulatory decisions. This paper discusses the regulatory restrictions on drilling discharges followed in various countries, the overall approach to assessment of environmental effects of drilling discharges, and the key results of scientific studies of the fate and effects of drilling discharges. The discussion focuses on wastes from drilling with water based drilling fluids, since these constitute the bulk of wastes generated during drilling.

Three conclusions emerge from a review of the scientific literature on the environmental effects of drilling discharges. The first is that low toxicity and rapid dilution prevent the occurrence of significant biological effects in the open ocean water column from the discharge of water based drilling fluids and cuttings. Based on extensive studies of drilling fluid toxicity, water based drilling fluids can be formulated reliably to be of low toxicity. The second conclusion is that the potential for biological effects on the seabed depends primarily on the energy of the seafloor environment. Seafloor impacts may not be detectable at all in high energy environments. When impacts are observed they appear to be physical in nature, highly localized, and temporary. The third conclusion is that heavy metals in drilling discharges are not a significant environmental hazard. With the exception of barium and sometimes chromium, heavy metals in drilling discharges are present in concentrations comparable to concentrations found in marine sediments. Sediment barium concentrations are usually elevated near the well site. However, barium and the other heavy metals in drilling discharges are present in chemical forms that greatly limit their solubility and bioavailability. Observed levels of bioaccumulation have not been high enough to be harmful to the affected animals or predators (including man). Barium, as well as other heavy metals in drilling discharges are not biomagnified in marine food webs.

Introduction

Scientific research conducted over the last twenty years has addressed concerns about the potential effects of the offshore discharge of waste drilling fluids and cuttings. After consideration of both the results of this research and the benefits of offshore oil and gas production, many countries have determined that discharges of drilling wastes are permissible under certain conditions. This paper discusses the scientific basis for these regulatory decisions. The approaches used in various countries for regulatory control of drilling discharges are reviewed, along



Joe Smith

with the overall approach to assessment of environmental effects of drilling discharges, the key results of scientific studies of the fate and effects of drilling discharges and the role of research results in regulatory decision making. The discussion focuses on wastes from drilling with water based drilling fluids, since these constitute the bulk of wastes generated during drilling.

Approaches for Regulation of Offshore Drilling Discharges

The regulatory controls on the discharge of water based drilling fluid and cuttings range from no restrictions at all to controls on locations of discharges, on the use of drilling fluid additives, and on the toxicity and composition of discharged drilling fluids and cuttings. Environmental monitoring may be required as a condition of obtaining permission to discharge. In general, cuttings drilled with water based fluids may be discharged if the discharge of the corresponding drilling fluid is permissible.

United States of America regulations prohibit discharges in waters closer than three miles to shore. This restriction does not apply to Alaskan waters. Due to limited depth and restricted mixing capabilities, inshore waters and confined bays are treated differently under U.S. regulations. Discharges of drilling fluid and cuttings are prohibited in these areas, which are called "coastal" rather than "offshore" waters. U.S. controls include a requirement to measure the toxicity of discharged drilling fluid monthly and at the end of the well to insure that it passes a drilling fluid toxicity limit and a requirement to pass a test that protects against discharge of fluids that cause "sheens" or "rainbows" on water. Controls on drilling fluid components prohibit the use of diesel as an additive to water based fluids, and limit the mercury and cadmium content of barite to 1 ppm and 3 ppm, respectively.

North Sea countries (e.g., UK, Norway, Denmark, and The Netherlands) apply regulatory controls that limit the toxicity, persistence and potential for bioaccumulation of individual drilling fluid additives. Environmental monitoring of discharge sites may be required as a condition of discharge permits.

Canada permits the discharge of water based drilling fluids and cuttings but operators are encouraged to develop procedures that reduce the need for bulk disposal of drilling fluids (National Energy Board of Canada, 1996).

Australia places no restrictions on additives except for a limit of 17% on the concentration of potassium chloride in drilling fluids used for exploration wells and a limit of 1% on the oil content of small batches of drilling fluids to which oil has been added to increase lubricity.

Framework for Environmental Evaluation of Drilling Discharges

During the past twenty years, an overall framework has developed for the environmental assessment of drilling discharges. This systematic approach, which forms the basis for this paper, addresses the following issues.

* Characterization of the effluent composition and volume.

* Assessment of environmental effects of discharges.

* Environmental monitoring and assessment.

Characterization of Effluent Composition and Volume

Drilling fluids and drill cuttings are the primary wastes generated during the drilling process. Drilling fluids are used to remove cuttings from the well bore, to maintain a positive pressure in the well bore to prevent formation fluids from entering the annulus, and to cool and lubricate the drill bit. Drilling fluids are classified according to the properties of the fluid phase as being water-based, oil-based, or synthetic-based. Water-based drilling fluids have either salt water or fresh water as the fluid phase. Oil based drilling fluids have a refined oil as the fluid phase. Synthetic-based drilling fluids have a fluid phase composed of an organic material synthesized from pure components. This paper will focus on the discharge of water based drilling fluids and cuttings since these constitute the bulk of wastes generated during drilling. Drill cuttings, which are pieces of rock that are removed from the formation being drilled, are carried to the surface suspended in the drilling fluid. Solids control equipment separates the drill cuttings from the drilling fluid, which is then reused.

The volumes of drill cuttings and drilling fluid

discharged during the drilling process depends on the depth of the well, the chosen hole diameters, the type of formation being drilled, the type of drilling equipment being used, and the efficiency of the solids control equipment. These factors vary widely for different drilling operations. General ranges of volumes discharged per well have been stated as 800 - 5000 m3 of drilling fluid and 500 - 1000 m3 of drill cuttings (National Research Council (US), 1983). The most carefully documented study of measured volumes of drilling fluid and cuttings discharges (Ayers et al., 1980b) reported discharges of 1018 m3 of cuttings and 4897 m3 of drilling fluids during drilling to a depth of 4970 m. Estimates (Hinwood et al., 1994 and USEPA, 1993) of volumes discharged in drilling to different depths vary depending on assumptions made in the calculations.

Table 1. *Volumes of Discharged Drilling Fluids and Drill Cuttings for Wells of Different Total Depth*

Total Depth (m)	Cuttings (m^3)	Drilling Fluids (m^3)	Source
800	128	501	Hinwood et al. (1994), estimate
1500	192	533	Hinwood et al. (1994), estimate
2500	451	853	Hinwood et al. (1994), estimate
3049	227	851	USEPA (1993), estimate
3500	518	924	Hinwood et al. (1994), estimate
4500	562	980	Hinwood et al. (1994), estimate
4970	1018	4897	Ayers et al. (1980b), measurment
5500	442	1667	USEPA, 1993, estimate

Drilling fluid is discharged intermittently during the drilling process in volumes of about 20 - 30 m3 as required to adjust the composition of the drilling fluid for optimum performance. A larger volume of drilling fluid (~200 m3) is discharged at the end of the drilling process or when drilling conditions require replacement of the entire drilling fluid system. Drilling fluids are discharged at rates of 80 - 300 m3hr-1. Drill cuttings, coated with a small amount of drilling fluid, are generated and discharged continuously during the drilling process at a low rate (0.2 - 2 m3hr-1).

Drilling fluid compositions vary with both the depth and location of the well. The bulk of water based drilling fluids consists of water, salts, barite, and bentonite (Table 2). The heavy metal content of drilling wastes is dominated by the barium from barite, with much lower concentrations of the other trace metals (Table 3). Comparison of the ranges of concentrations of metals found in drilling fluids and marine sediments provides a perspective on the potential for drilling discharges to alter sediment chemistry. Although comparisons of the ranges of concentrations emphasize the highest and lowest values rather than typical values, the data in Table 4 indicate that drilling fluids have higher concentrations of barium and chromium than do marine sediments. However, concentrations of other metals in drilling fluids are similar to metal concentrations in marine sediments.

Table 2. *Representative Drilling Fluid Compositions*

Lignosulfonate Drilling Fluid		Polymer Drilling Fluid	
Component	Weight %	Component	Weight %
Sea water	76	Salt water	80
Barite	15	Barite	17
Bentonite	7	Bentonite	2
Lingnosulfonate	1	Partially hydrolyzed Polyacrylamide(PHPA)	0.2
Lignite	1	Xanthan gum biopolymer	0.2
Starch	0.2	Starch	0.6

Table 3. *Example Metal Content of Drilling Waste (National Research Council (US), 1983)*

Metal	Effluent Concentration ($mg.kg^{-1}$)	
	Shale Shaker Discharge (Drill Cuttings) (77% wt solids)	Discharged Drilling Fluid (21% wt solids)
Barium	3160	37,400
Chromium	44	191
Cadmium	<2	<1
Lead	10	3
Mercury	<1	<1
Nickel	15	4
Vanadium	11	5
Zinc	80	50

Table 4. *Concentration Ranges of Metals in Water Based Drilling Fluids and in Typical Marine Sediments (Neff, 1988)*

Metal	Concentration Range for Drilling Fluid ($mg.kg^{-1}$ dry weight)	Concentration Range for Marine Sediments ($mg.kg^{-1}$ dry weight)
Barium	720 - 49.000	60 - 8,100
Chromium	10.9 - 1159	10 - 200
Cadmium	0.5 - 3.5	0.3 - 1
Copper	2.8 - 119	8-700
Iron	16,000 - 27,000	20,000 - 60,000
Mercury	0.015 - 2.8	0.05 - 3.0
Lead	5.0 - 241	6 - 200
Zinc	42 - 397	5 - 4,000
Nickel	3.8 - 19.9	2 - 10 (10 - 1,000)
Arsenic	1.8 - 2.3	2 - 20
Vanadium	14 - 28	10 - 500
Manganese	290 - 400	100 - 10,000

1. Nickel concentrations of 10 - 1,000 mg.kg-1 are typical of deep-sea sediments.

Assessment of Environmental Effects of Discharges

OVERVIEW

The environmental effects of the discharge of water based drilling fluids and cuttings have been the focus of extensive research dating from the mid-1970's. A systematic framework for assessment of environmental effects has developed which includes characterization of effluent toxicity and potential for bioaccumulation, prediction of environmental exposure concentrations through field observation and dispersion modeling, and evaluation of effects on pelagic (i.e. living in the water column) and benthic (i.e., sediment-dwelling) biological communities. This framework forms the basis for an overall assessment of the risk posed by marine discharges.

TOXICITY OF WATER BASED DRILLING FLUIDS

Laboratory Bioassay Testing of Drilling Fluids

Since the early 1970's bioassays have been performed on water based drilling fluids and individual drilling fluid components using a wide variety of species in the US and Canada. The results of this research demonstrate that modern water based drilling fluids are very low in toxicity. Experience with bioassay testing of thousands of drilling fluid samples used in actual drilling operations demonstrates that there is a very high degree of confidence that drilling fluids can be formulated to be essentially non-toxic.

Bioassay testing of drilling fluids focuses on the toxicity of whole drilling fluid or of individual drilling fluid components added to a base drilling fluid. This approach developed, after an early emphasis on the toxicity of individual drilling fluid components, because regulators wanted to use bioassay results to help predict biological impacts of operational drilling fluid discharges to the ocean and research showed that bioassay test results for individual components might be considerably different from bioassay test results obtained on those same components in an actual drilling fluid (Sprague and Logan, 1979).

By 1983, water based drilling fluids had been tested on 62 different species of marine animals from the Atlantic and Pacific oceans, the Gulf of Mexico, and the Beaufort Sea (National Research Council (US), 1983). Larval, juvenile, and molting crustaceans were found to be more sensitive to drilling fluids than most other life stages and most other species. The U.S. Environmental Protection Agency (USEPA) chose one of the more sensitive crustacean species, Mysidopis bahia, as the standard organism for use in

drilling fluid bioassays and imposed a toxicity limit on drilling fluid discharged to U.S. marine waters.

U.S. operators are required to perform bioassays on the drilling fluid each month during drilling and at the end of the well. The U.S. regulatory protocol (USEPA, 1985) measures the toxicity of the suspended particulate phase (SPP), a 1:9 mixture of drilling fluid and seawater. Experience has shown that for any drilling fluid, unfiltered SPP is consistently the most toxic phase. Toxicity tests are conducted by exposing test organisms to a series of concentrations of SPP and measuring the percent survival at each concentration. Toxicity is expressed as the 96-hour LC50, the concentration at which 50% of the test organisms remain alive after 96-hour exposure. The U.S. drilling fluid toxicity limitation specifies that the 96-hour LC50 for the SPP must exceed 30,000 ppm. The 30,000 ppm standard is met routinely. Data collected by the USEPA from 1986 to 1989 showed that 99.9% of 10,397 Gulf of Mexico drilling fluid bioassays yielded 96 hour LC50 values in excess of 30,000 ppm (Science Applications International, Inc., 1992). Experience with bioassay testing has taught drilling fluid service companies how to reliably formulate drilling fluids of low toxicity. This experience has shown that some additives that were commonly used in past years will significantly lower the LC50. Therefore, these additives are not used in drilling fluids that are to be discharged. For example, drilling fluids containing diesel fuel cannot be discharged because as little as one percent diesel can lower the 96 hour LC50 to less than 1,000 ppm SPP (Ayers et al., 1989). The International Maritime Consultative Organization developed a system for classifying, according to ranges of LC50 values, the toxicities of chemicals that might be discharged into the sea (IMCO/FAO/UNESCO/WMO, 1969). This system provides a useful perspective on the low toxicity of water based drilling fluids. The minimum 96-hour LC50 value for the SPP of drilling fluids discharged in the U.S. is 30,000 ppm. Many drilling fluids have 96-hour LC50s in excess of 100,000 ppm. These concentrations correspond approximately to 3,000 ppm and 10,000 ppm whole drilling fluid, respectively, since whole drilling fluids are diluted 1:9 with seawater before conducting the bioassay test. Figure 1 compares the toxicities of the "Generic Muds", i.e. eight basic compositions that cover most of the drilling fluids used offshore (Ayers et al., 1985), with the toxicities of drilling fluids containing oil. Also shown, for comparison purposes, are the toxicities of some more highly toxic chemicals (e.g. pesticides, very toxic biocides, and cyanide) which are not used in drilling fluids. Note that water based drilling fluids fall into the "slightly toxic" to "practically non-toxic" categories in the classification system.

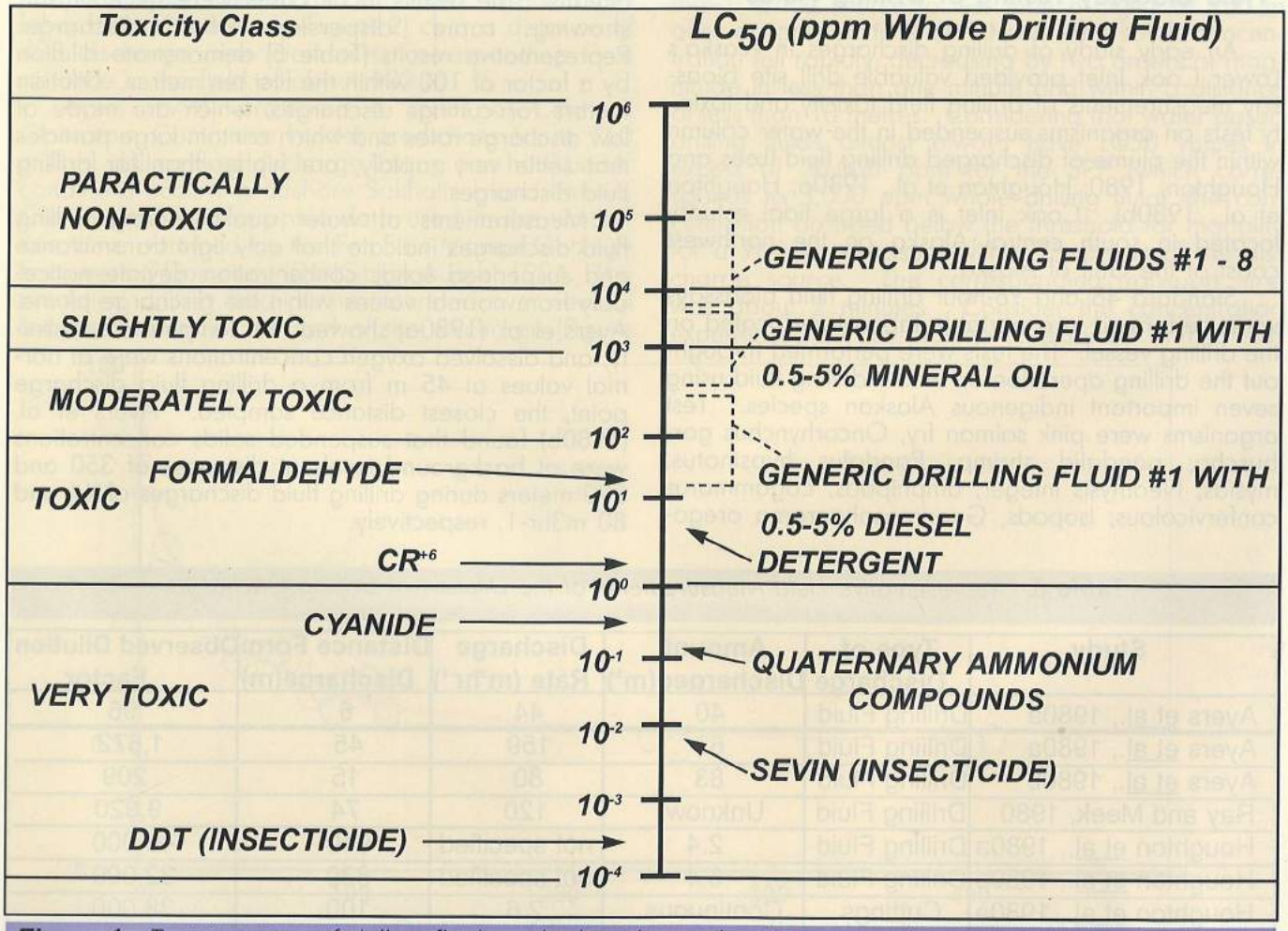
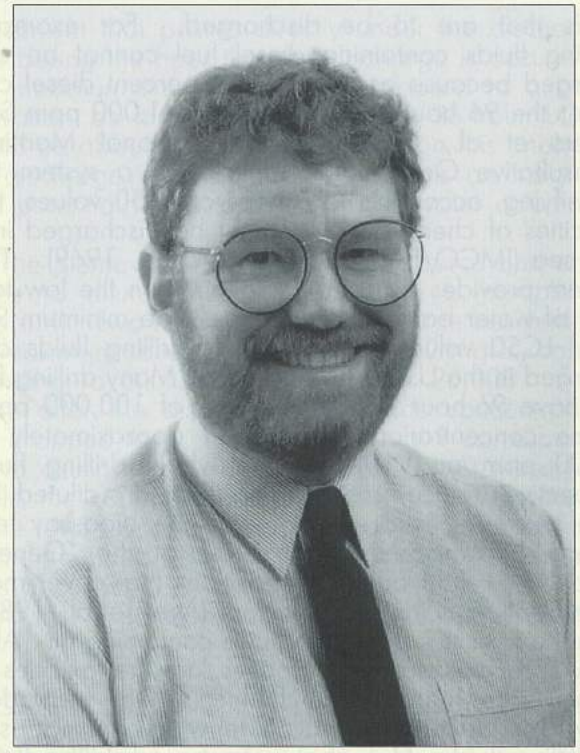


Figure 1. *Toxicity rating of drilling fluids and other chemicals. The toxicity classes represent ranges of LC50 values in the IMCO toxicity classification scheme (IMCOIFAO/UNESCO/WMO Joint Group of Experts on the Scientific Aspects of Marine Pollution, 1969). LC50 values are indicated for the generic drilling fluids (Ayers et al., 1985) a set of common water based drilling fluid compositions, generic drilling fluids containing oil, and other chemicals (insecticides, detergents, highly toxic biocides, hexavalent chromium) not found in drilling fluids.*



Russel Tait

Field Bioassay Testing of Drilling Fluids

An early study of drilling discharges in Alaska's Lower Cook Inlet provided valuable drill site bioassay measurements of drilling fluid toxicity and toxicity tests on organisms suspended in the water column within the plume of discharged drilling fluid (Lees and Houghton, 1980; Houghton et al., 1980a; Houghton et al., 1980b). Cook Inlet is a large tidal estuary located in south central Alaska on the northwest coast of the Gulf of Alaska.

Standard 48 and 96-hour drilling fluid bioassays were performed in a portable laboratory located on the drilling vessel. The tests were performed throughout the drilling operation on whole drilling fluid using seven important indigenous Alaskan species. Test organisms were pink salmon fry, Oncorhynchus gorbuscha; pandalid shrimp, Pandalus hypsinotus; mysids, Neomysis integer; amphipods, Eogammarus confervicolous; isopods, Gnorimosphaeroma oregonensis; staghorn sculpin, Leptocottus armatus; and mussels, Modiolus modiolus.

Pink salmon was the most sensitive species tested with 96-hour LC50 s ranging from 3,000 - 30,000 ppm whole drilling fluid. All the other species yielded 96-hour LC50 s falling between 32,000 and greater than 200,000 ppm whole drilling fluid.

In-situ bioassay tests were used to measure the effects of drilling fluid on marine organisms under actual field exposure conditions. Pink salmon fry and hermit crabs Elassochirus gilli were suspended in live boxes at 100, 200 and 2,000 metres (as a control) down-current from the discharge source. After four days of exposure, there were no mortalities that could be attributed to the drilling fluid discharge plume.

DISPERSION OF DRILLING FLUID DISCHARGES

Field Observations of Drilling Fluid Dispersion

Field observations have shown repeatedly that drilling fluid disperses rapidly after discharge. Field studies of drilling fluid dispersion have been conducted in the Gulf of Mexico (Ayers et al., 1980a); Cook Inlet (Houghton et al., 1980a), the Beaufort Sea (Miller et al., 1980); Norton Sound (ECOMAR, 1983); and the Atlantic (Ayers et al., 1980b) and Pacific (Ray and Meek, 1980, O'Reilly et al., 1989) oceans. The results in all cases were quite similar, showing rapid dispersion after discharge. Representative results (Table 5) demonstrate dilution by a factor of 100 within the first ten metres. Dilution factors for cuttings discharges, which are made at low discharge rates and which contain large particles that settle very rapidly, are higher than for drilling fluid discharges.

Measurements of water quality during drilling fluid discharges indicate that only light transmittance and suspended solids concentration deviate noticeably from normal values within the discharge plume. Ayers et al. (1980a) showed that temperature, salinity, and dissolved oxygen concentrations were at normal values at 45 m from a drilling fluid discharge point, the closest distance sampled. Ayers et al. (1980b) found that suspended solids concentrations were at background levels at distances of 350 and 590 meters during drilling fluid discharges of 44 and 80 m3hr-1, respectively.

Table 5. *Representative Field Measurements of the Dilution of Drilling Discharges*

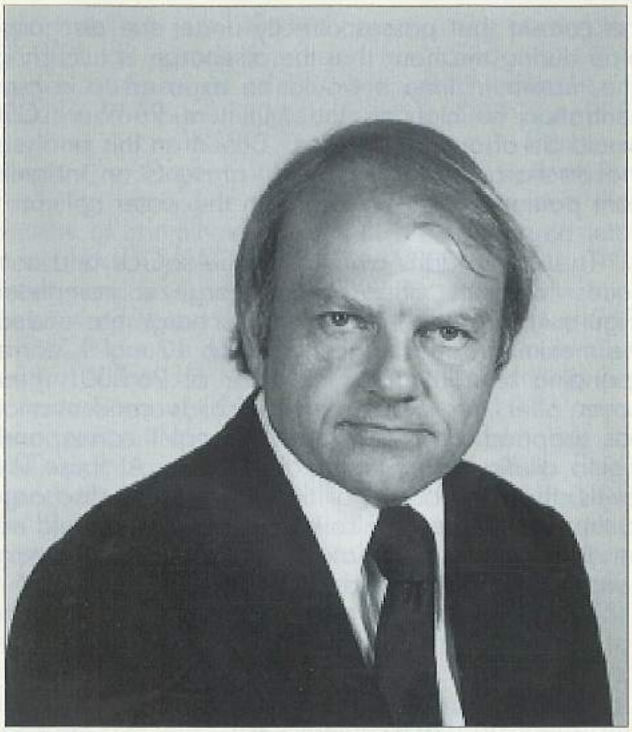
Study	Type of Discharge	Amount Discharged(m^3)	Discharge Rate (m^3hr^{-1})	Distance Form Discharge(m)	Observed Dilution Factor
Ayers et al., 1980a	Drilling Fluid	40	44	6	96
Ayers et al., 1980a	Drilling Fluid	62	159	45	1,672
Ayers et al., 1980b	Drilling Fluid	83	80	15	209
Ray and Meek, 1980	Drilling Fluid	Unknow	120	74	9,920
Houghton et al., 1980a	Drilling Fluid	2.4	not specified	940	46,000
Houghton et al., 1980a	Drilling Fluid	6.4	not specified	830	22,000
Houghton et al., 1980a	Cuttings	Continuous Discharge	2.6	100	38,000
Houghton et al., 1980a	Cuttings	Continuous Discharge	2.6	400	143,000
O'Reilly et al., 1989	Drilling Fluid	43	85	10	183
O'Reilly et al., 1989	Drilling Fluid	43	85	100	1,049

Numerical Modeling of Drilling Fluid Dispersion

Numerical modeling provides predictions of effluent concentrations based on algorithms representing the physical processes that control dispersion and on site specific discharge and receiving water conditions. Model predictions, verified by comparison with field and laboratory observations of plume behavior, illustrate the rapid dilution of drilling fluids after discharge. Predictions show that increases in water column solids concentration are highly localized and limited in duration.

The Offshore Operators Committee Mud and Produced Water Discharge Model is a computer program that predicts the initial fate of drilling fluid, drill cuttings, and produced water discharged into the marine environment (Brandsma et al., 1980, 1983a and 1983b). The predictions of this model have been used in the development of regulations in the U.S. (Avanti Corporation, 1993) and incorporated in the CHARM (Chemical Hazard Assessment / Risk Management) model developed for use in the North Sea (Karman and Vik, 1996). The model's predictions have been validated by comparison to the results of field (O'Reilly et al., 1988) and laboratory observations of drilling fluid plume behavior. In a laboratory study, the model accurately predicted the maximum water column concentrations observed in a laboratory plume study (Figure 2) over a distance of 400 discharge pipe diameters, corresponding to a distance in the field of about 100 m.

Ayers (1994) presented a series of Offshore Operators Committee model predictions for a 160 m3hr-1 drilling fluid discharge lasting one hour under conditions occurring offshore Sakhalin Island, Russia. Current and hydrographic data used in the simulation were obtained by the Far East Marine Geology Engineering Company (DMIGE) in August 1994. The predicted drilling fluid plume extended over several hundred metres at the end of the discharge (Figure 3). The solids concentration dropped from 300,000 mgl-1 at the source to less than 8 mgl-1 at 750 m after a transport time of 1 hour. The solids concentration fell rapidly, decreasing by two orders of magnitude in less than one minute and within a distance of less than 10 metres. Considering that water based drilling fluids almost always have LC50 values in excess of 30,000 ppm for the SPP (which corresponds to 3,000 ppm whole drilling fluid), the concentration dropped below the threshold for mortality for a 96-hour exposure within 15 meters of the discharge source. The corresponding transport time was about 2 minutes. Consider the concentration experienced by any planktonic organism drifting with



Robert Ayers

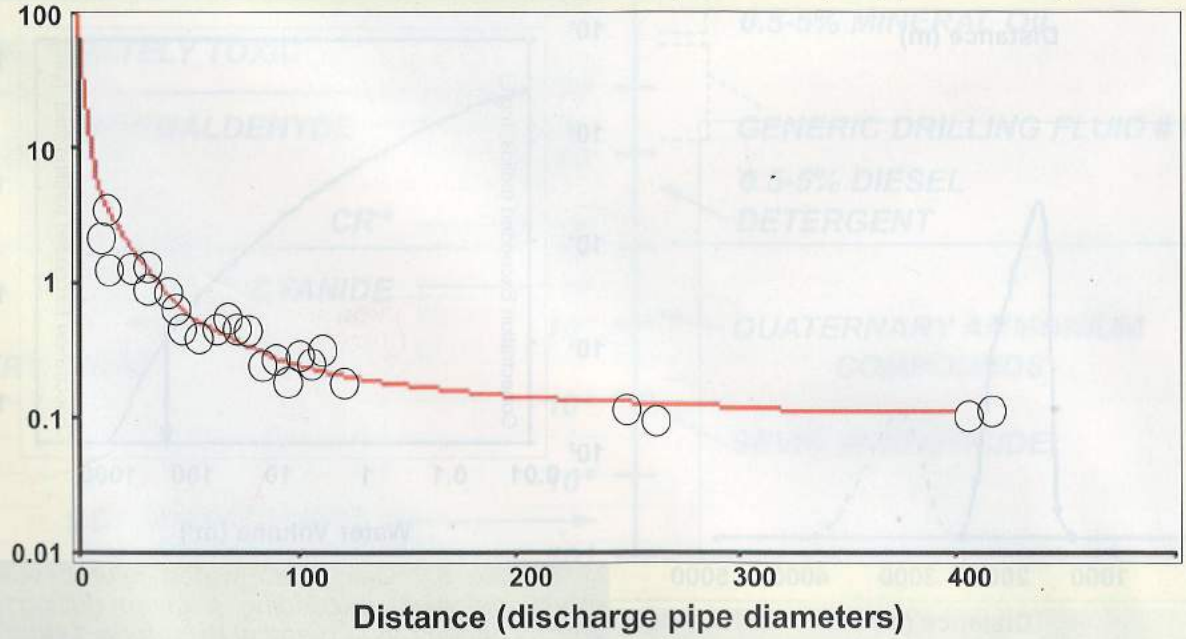
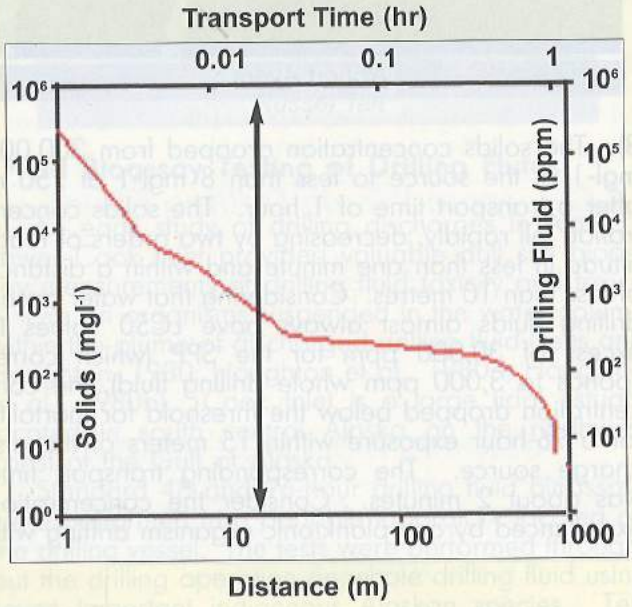


Figure 2. *Comparison of model predictions (solid line) of maximum water column concentration of drilling fluid solids with laboratory observations (O). Solids concentration is expressed as a per cent of initial drilling fluid concentration. The distance from the discharge is expressed in dimensionless units of discharge pipe diameters. A distance of 400 pipe diameters corresponds to approximately 100 m under field conditions.*

the current that passes directly under the discharge pipe during the hour that the discharge is occurring. The maximum time it would be exposed to a concentration as high as the minimum 96-hour LC50 would be about 1.2 minutes. Based on this analysis, the discharge of drilling fluids presents an insignificant potential for toxic effects in the water column.

The plume drifts away from the source and continues to dilute after the discharge is completed (Figure 4). Two hours after the discharge has ended, the maximum solids concentration is 12 mgl-1, corresponding to dilution by a factor of 26,000. Four hours after the discharge, the solids concentration has dropped to a maximum of 4 mgl-1 corresponding to dilution by a factor of 78,000. At these low levels, the contribution of the drilling fluid discharge to the total suspended solids concentration could not be distinguished from natural background concentrations of suspended solids.

Model predictions also allow calculation of the volume of water that has a concentration that exceeds a given concentration of drilling fluid. A threshold for mortality of 3,000 ppm whole drilling fluid, corresponding to approximately 1,000 mgl-1 solids, provides a conservative standard for comparison. The modeling results (Figure 5) show that the threshold concentration for toxicity in a 96-hour bioassay is exceeded in a water column volume of only about 250 m3 and only during the time that the drilling fluid is actually being discharged. Cuttings, which are discharged at lower rates than drilling fluids, and which contain larger particles which settle out more quickly than fine drilling fluid solids, are diluted even more rapidly than drilling fluids. The low toxicity of water based drilling fluids and cuttings, the short exposure times to potentially toxic concentrations, and the small volume of water affected clearly indicate that significant biological effects in the water column are extremely unlikely. Hence, drilling fluid and cuttings discharges do not pose a significant risk of adverse effects in the water column.



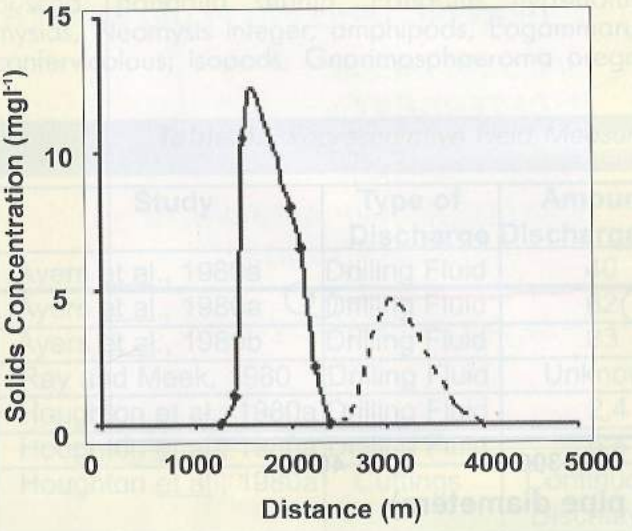


Figure 4. *Predicted water column concentration of drilling fluid solids at 2 hours (solid line) and at 4 hours (dashed line) after the end of a 1 hour discharge.*

Figure 3. *Predicted water column concentration of drilling fluid at the end of a 1 hour discharge. The vertical axes show the maximum suspended solids concentration (left scale) and drilling fluid concentration (right scale). The horizontal axes show distance from the discharge and transport time, i.e., the time it takes a parcel of fluid moving with the current to reach that distance. The concentration drops below 3,000 ppm whole drilling fluid (arrows), corresponding to the minimum LC50 permitted for discharge in US waters, within a distance of 20 m and a time of 2 minutes. The change in slope at 50 m corresponds to the transition between rapid near-field dilution and slower far field dilution of the discharge plume. The sharp decrease in concentration at 750 m indicates the maximum distance the plume travels during the discharge.*

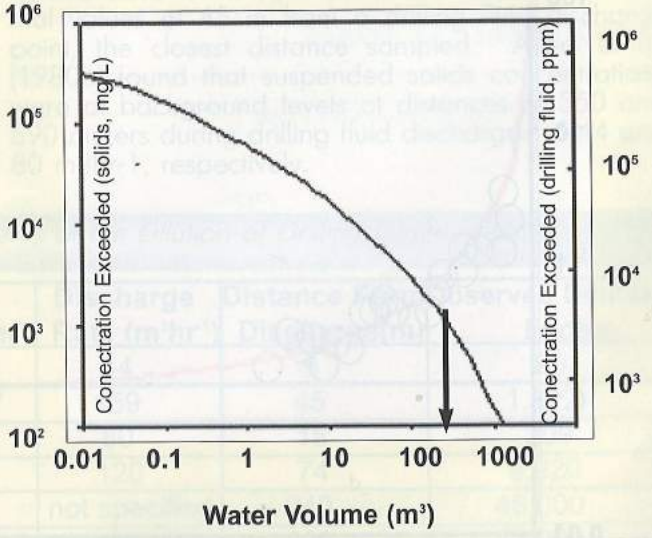


Figure 5. *Calculated water column volume (horizontal axis) exceeding a given drilling fluid solids concentration (vertical axis) for a 1 hour discharge of drilling fluid at a rate of 160 m3hr-1. A concentration of 3,000 ppm whole drilling fluid (arrow), corresponding to the minimum LC50 permitted for discharge in U.S. waters, is exceeded in a volume of only 250 m3.*

SEAFLOOR IMPACTS

Overview of Seafloor Environmental Studies

Studies of the seafloor impacts of the discharge of water based drilling fluids have examined sediment chemistry for evidence of the accumulation of drilling fluid components and the structure and health of benthic communities for evidence of biological effects. Studies of the effects of water based drilling fluid and cuttings discharges clearly indicate the importance of the energy of the water column and seafloor environment in determining the extent and duration of environmental effects. No effects on sediment chemistry or biology may be detectable at all under high-energy conditions. Localized effects on chemistry and biology may be detectable for low-energy seafloor environments. These findings are illustrated by the following discussion of three important studies of seafloor effects of drilling discharges: the Lower Cook Inlet Study (1977), the Georges Bank Monitoring Program (1981 - 1984) and the Mid-Atlantic Monitoring Program (1979-1980). More recent studies of the seafloor effects of drilling discharges support the results of earlier research on this issue.

The Lower Cook Inlet Study (Lees and Houghton, 1980; Houghton et al., 1980a and Houghton et al., 1980b) followed on from the bioassay work and examined the seafloor effects of drilling discharges. Cook Inlet has a very high-energy environment characterized by large tidal fluctuations and strong currents. The seafloor data were collected in during a single sampling cruise.

The Georges Bank Monitoring program (Neff et al., 1989 and Bothner et al., 1985) was a comprehensive study of both area wide and site specific impacts from exploratory drilling. This study is of special interest due to the importance of Georges Bank as a major commercial fishery with catches of species of finfish and shellfish including cod, haddock, flounder, ocean scallops and lobster with an annual market value of over $165 million dollars in 1982. The physical environment is highly energetic. The seafloor topography in that area is characterized by large sand waves and ridges. Tidal currents continuously rework the sediments, leaving only coarse sand. Sites were samples four times per year over a three year period ending two years after the completion of drilling operations.

The Mid-Atlantic Monitoring program (Ayers et al., 1980; Menzie et al., 1980; EG&G, 1982 and Gillmor et al., 1985) was directed at studying the effects of drilling discharges in the Baltimore Canyon area off the East Coast of the US. The physical environment was characterized by a smooth, sandy bottom topography with extremely slow bottom current speeds. Sites were sampled before drilling, immediately after drilling, and one year after drilling.

The results of these studies reflect the strong influence that ocean environmental factors have on how the drilling discharges effect the seafloor (Table 6). The severity of impact and rate of recovery depends primarily on the energy of the seafloor environment. The Cook Inlet Study was conducted in relatively shallow water with exceptionally high bottom currents. In this case, bottom photography was unable to detect any visual evidence of drill cuttings on the seafloor after drilling. Further, barium levels in the sediment were not elevated and there was no measurable effect on the benthic community.

Environmental conditions at Georges Bank are somewhat less energetic than in Cook Inlet. Bottom currents are less and water depth is greater. There was no visual evidence of cuttings on the seafloor after drilling. However, sediment barium levels were elevated near the well site. As was the case in Cook Inlet, there was no measurable effect on the benthic community after drilling.

The site of the Mid-Atlantic study represents a relatively low energy environment where bottom currents were much slower than in Cook Inlet or Georges Bank. The water depth was such that storm waves had little effect on the seafloor environment. Physical disturbance of the seabed (cuttings accumulations and depressions caused by anchor chains) were observed immediately after drilling and were still visible one year after drilling. Elevated sediment barium concentrations were observed in both post-drilling surveys. Immediately after drilling, macrobenthic abundance (but not diversity) was depressed in the well site area. The abundance of megabenthic organisms (demersal fish and crabs) increased after drilling. Only minor biological effects were detected after one year. There was a cluster of stations within 100 m of the well site that exhibited a decreased density of echinoderms (brittle starfish). It was clear that this effect was highly localized because it was reported that a station less than 50 m from the cluster of decreased density stations had the highest density of echinoderms. The abundance of macrofauna in the post drilling study area exhibited only weak spatial trends and no correlation with barium concentrations in the sediments.

More recently, Muschenheim and Milligan (1996) reported the results of video of surveys of a drilling site in 30 m deep water on the Scotian Shelf of Canada. Video surveys conducted immediately after drilling revealed visible deposits of particulate drilling waste covering variable fractions of the survey area within 2 km of the drill site. A second survey taken 7 months later showed one or two small deposits of visible particulates but none of the extensive coverage observed in the earlier study. Analysis of the bottom current speeds indicated that they were sufficiently energetic to resuspend the particulates deposited during drilling so that they could not be detected in the later survey. Chapman et al. (1991) examined data from a production platform with four wells in 25 m deep water in the U.S. Gulf of Mexico and found that measurable effects on the benthic environment were confined to stations within 25 m of the platform. Overall, Chapman et al. found "little if any degradation/impact" from drilling and production activities. This study showed that enrichment of sediments by drilling waste components did not necessarily lead to adverse biological effects.

Table 6. *Effect of Ocean Environment on Seafloor Impacts of Drilling Discharges (National Research Council (US), 1983)*

Study	Cook Inlet	Georges Bank	Mid-Atlantic
Environmental Factors			
Maximum Bottom Curent ($cm.s^{-1}$)	99	>35	19
Water Depth (m)	62	60-150	120
Study Results			
Visual evidence of cuttings after drilling	NO	NO	YES
Elevated barium levels in sediments after drilling	NO	YES	YES
Measurable effects on benthic community	NO	NO	YES

BIOACCUMULATION OF HEAVY METALS FROM DRILLING DISCHARGES IN MARINE ORGANISMS

Laboratory studies of bioaccumulation of drilling fluid metals in marine organisms have generally found a small degree of barium and chromium uptake and little or no accumulation of other metals (Neff et al., 1988a and 1988b). When bioaccumulation has been observed it has not been high enough to be harmful to the accumulating animals or predators. Studies of the bioaccumulation of mercury, cadmium, copper, lead, and arsenic from pure and impure barite (Neff, 1988b) concluded that the metals associated with drilling fluid barite are virtually non-available for bioaccumulation by marine organisms that might come in contact with discharged drilling fluid solids. Field studies have generally confirmed the low levels of metal bioaccumulation observed in the laboratory studies. Attempts to correlate elevated sediment concentrations of barium, occasionally chromium, and rarely zinc, cadmium, lead and mercury near drilling sites with accumulations of metals in tissues of resident benthic or demersal (i.e., bottom-feeding) fauna found small increases in barium levels in some studies and none in others. Rarely were increases in other metals observed (Ray and Meek, 1980; Crippen et al., 1980; Gettleson and Laird, 1980; Tillery and Thomas, 1980; Wheeler et al., 1980; Northern Technical Services, 1981; EG&G Environmental Consultants, 1982; Bothner et al., 1985 and Trefry et al., 1985).

Heavy metals in drilling fluids do not biomagnify in marine food webs (Neff et al., 1988a and 1988b). Similar results have been found in studies of biomagnification of heavy metals from sources other than drilling fluids. With the exception of organomercury compounds, which are not found in drilling waste discharges, concentrations of most metals in natural marine food webs show either no relation or an inverse relation to trophic level, indicating that food chain biomagnification of inorganic metals does not occur (Kay, 1984; Bascom, 1983; Amiard et al., 1980; Young and Mearns, 1979 and Schafer et al., 1982).

CONCLUSIONS OF RESEARCH ON ENVIRONMENTAL EFFECTS OF DRILLING DISCHARGES

Review of the extensive body of research on environmental effects of water based drilling fluid and cuttings discharges in the marine environment leads to the following major conclusions.

1. There are no significant biological effects in the open ocean water column from the discharge of water based drilling fluids. Water based drilling fluids exhibit low toxicity and discharges are rapidly dispersed. Within minutes after discharge, drilling fluid concentrations fall below the lowest 96-hour LC50 concentrations measured for drilling fluids permitted for discharge.

2. Measurable physical and biological effects may occur at the seafloor in the vicinity of the well site. The degree of impact depends primarily on the energy of the seafloor environment. Impacts may not be detectable at all in high-energy environments. Physical disturbances and minor biological effects may be observed in lower energy environments. These effects tend to be highly localized and temporary.

3. Heavy metals in drilling discharges are not a significant environmental hazard. With the exception of barium and sometimes chromium, heavy metals in drilling discharges are present in concentrations comparable to those found in marine sediments. Sediment barium concentrations are almost generally elevated near the well site. However, barium and the other heavy metals in drilling discharges are present in chemical forms that greatly limit their solubility and bioavailability. Observed levels of bioaccumulation have not been high enough to be harmful to the affected animals or predators (including man). Barium, as well as other heavy metals in drilling discharges are not biomagnified in marine food webs.

Environmental Monitoring of Drilling Discharges

Monitoring studies completed to date have addressed the fate and effects of discharges under a wide variety of environmental conditions including waters of arctic and subarctic regions (Beaufort Sea, Norton Sound and Cook Inlet), California, Australia, Malaysia, the Gulf of Mexico, the North Sea and the U.S. Atlantic Coast. Historically, as hydrocarbon

resources have been discovered in previously undeveloped provinces, the results of existing research have provided the scientific basis for permitting the initial discharge of drilling wastes. Site specific studies are conducted to confirm that environmental effects are acceptable and limited in area and extent or to address issues of particular local concern. This information provides the basis for evaluating the acceptability of making discharges to the marine environment over the longer term.

Consideration of Scientific Findings in Regulatory Decision Making

Research on the effects of drilling discharges has been useful in making decisions concerning the regulation of offshore operations. An intense period of study during the 1970s and 1980s resulted in a detailed understanding of effluent composition and toxicity, potential for bioaccumulation, and potential for effects on organisms in the water column and on the sea bottom. Based on the results of this research, it has generally been concluded that offshore discharges may be permitted without significant risk to the marine environment. Restrictions have been adopted as appropriate to address certain categories of wastes or to protect areas of limited mixing or especially sensitive biological communities. Periodically, decisions to permit discharges are re-evaluated and adjustments in regulations are made or additional restrictions added to take into account new information or the characteristics of areas of increased environmental sensitivity. Overall, research has provided a basic framework of knowledge concerning these practices and there is a widespread acceptance of the concept that open ocean discharges of water based drilling fluids and cuttings can be made without unacceptable degradation of the marine environment.

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Caspian Environmental Laboratory
Experiences from one year of operations

Опыт, приобретенный в результате одного года работы
Каспийская Экологическая Лаборатория

Environment & Resource Technology Ltd

Каспийская Экологическая Лаборатория, оснащенная самым современным оборудованием, расположена в Баку, Азербайджан.

Гос.Комитета Экологии Али Гасанова и Президента Академии Наук Азербайджана Фарамаза Магсудова.

Dr. Brian Roddie, Senior consultant, Caspian Business Development
Др. Брайан Роди ,Старший консультант, Развитие Каспийского Бизнеса

Лаборатория создана на основе сотрудничества Международной Экоэнергетической Академии и Kvaerner ERT.

Целью лаборатории является предоставление услуг, соответствующих международным стандартам, в области мониторинга окружающей среды, анализа и тестов, а также написания отчетов для промышленного сектора и государства.

Сооружение лаборатории имело целевой характер, и она оснащена новейшим биологическим и химическим оборудованием, проводит обучение и развитие персонала, на 80% состоящего из азербайджанцев.

Начиная с середины 1997 г., партнерство проводит большую работу по проектированию, закупкам, строительству, формирование штата и вводу в эксплуатацию Лаборатории. Официальное открытие лаборатории состоялось 11 марта 1998 года, с участием Председателя

Caspian Environmental Laboratory State-of-the-art facility located in Baku, Azerbaijan

The Laboratory is a partnership between the International Ecoenergy Academy and Kvaerner ERT.

Its purpose is to provide international-standard services in environmental monitoring, analysis and testing, and reports to industry and government.

The laboratory is purpose-built, is equipped with the latest biological and chemical methods, and is committed to the training and development of its staff, over 80% of whom are Azeri.

The partnership has worked hard since the middle of 1997 on design, procurement, construction, recruitment and commissioning, of the Laboratory

We signalled the first landmark success when the Laboratory was officially opened on I 1 March 1998 by;

Mr. Ali Hasanov, Chairman of State Committee of Ecology and Mr.Feramaz Maksudov, President of the Academy of Sciences.

A major driving force in the creation of the Laboratory was

Главной движущей силой в создании Лаборатории была поддержка со стороны Азербайджанской Международной Операционной Компании (AMOK) в:

1) Создании экологической лаборатории, способной производить мониторинг операций, связанных с нефтью и газом в бассейне Каспия в соответствии с самыми высокими международными стандартами.
и

the commitment of the Azerbaijan International Operating Company (AIOC) to support:

1) the establishment of an environmental laboratory capable of monitoring oil and gas operations in the Caspian to the highest international standards

and

2) the development of Caspian Specific Ecotoxicological Procedures (CSEP) for assessing and regulating chemi cals used in drilling, production and associated operations.

Strategic support is supplied through ERT Caspian and the International Ecoenergy Academy

Bill Harris, General manager, Caspian Environmental Laboratory

Бил Харис, Генеральный менеджер, каспийская Экологическая Лаборатория

2) Разработке Каспийских Специфических Экотоксикологических Процедур (КСЭП) для оценки и регулирования химикатов, используемых при бурении и добыче, а также связанными с этим работами.

Стратегическая поддержка была оказана ERT Caspian и Международной Экоэнергетической Академией, а также техническими советами и поддержкой специалистов Азербайджана и Великобритании по вопросам окружающей среды.

and

Technical advice and support is available from both Baku and UK based environmental specialists.

A key requirement was that the laboratory should be capable of biological and chemical monitoring and testing in compliance with established international technical and quality standards.

To achieve this, agreement was reached between Azeri regulators and scientists, in co-operation with AIOC environmental staff, on a defined suite of monitoring and analysis techniques.

In addition, formal recommendations were made that the development of ecotoxicological methods should follow the model established by OSPAR in the North Sea.

Quality assurance and quality control targets were identified at an early stage, and the laboratory is designed and managed to comply with the principles of Good Laboratory Practice.

Good Laboratory Practice, is a formal international standard set by OECD, which forms the basis of regulatory science in the majority of developed countries.

The laboratory has already successfully passed preliminary audits, and aims to be the first laboratory in the newly independent states of the former Soviet Union, and the first laboratory in Central Asia, to achieve full formal GLP accreditation. This will establish the laboratory at the highest level of international performance.

The Laboratory carries out environmental scientific work on a commercial basis.

In practice, industrial clients, who commission the work on the instruction of the Azeri regulatory authorities, pay for commercial work.

The results of such work are assessed by the regulatory authorities to ensure that industrial activities operate to established standards of environmental responsibility.

The scope of the Laboratory's services covers a wide range of scientific activities:

Лаборатория в основном предназначена для проведения биологических и химических мониторингов и тестирования в соответствии с установленными международными техническими и качественными стандартами.

Для достижения этих целей было заключено соглашение между Лабораторией, Азербайджанскими учеными и регулирующими органами, при сотрудничестве со штатом AMOK, занимающимися вопросами окружающей среды, относительно установленных методологий проведения мониторинга и анализов.

Кроме этого, официальные рекомендации были сделаны с учетом того, чтобы разработка экотоксикологических методов соответствовала модели, утвержденной Конвенцией ОСПАР в Северном море.

В самом начале своей деятельности, Лаборатория поставила целью проведение контроля качества работы, который должен соответствовать принципу GLP (Хорошая Лабораторная Практика). Хорошая Лабораторная Практика является официальным международным стандартом, утвержденным OECD (Организацией Экономического Сотрудничества и Развития), и составляет основу научного законодательства для большинства развитых стран.

Успешно пройдя первый предварительный контроль, Лаборатория ставила целью достижение статуса первой Лаборатории среди независимых государств бывшего Советского Союза, а также Центральной Азии для достижения аккредитования Хорошей Лабораторной Практики. Это выведет Лабораторию на высший уровень международных стандартов.

Лаборатория выполняет экологическую научную работу на коммерческой основе. На практике, промышленные предприятия, которые заказывают работу по поручению Азербайджанских исполнительных властей, оплачивают коммерческую работу. Исполнительные власти проводят проверку результатов выполненной работы для оценки согласованности работающих промышленных предприятий с установленными экологическими стандартами.

Область предоставляемых услуг Лаборатории имеет широкий спектр научной деятельности:

. Морские биологические и химические исследования
. Анализ воды, отложений и тканей на наличие углеводородов, и других органических химикатов
. Анализ воды, отложений и тканей на наличие тяжелых металлов
. Таксономический анализ водной толщи и образцов донных отложений
. Математический анализ таксономических данных
. Экологическая оценка
. Экологическое тестирование образцов окружающей среды и промышленных химикатов
. Мониторинг воздуха

В течение одного года (по март 1999 г.), Лаборатория создала существенное количество аналитических методов для проведения

. Marine biological and chemical surveys
. Analysis of water, sediment and tissue for hydrocarbons and other organic chemicals
. Analysis of water, sediment and tissue for heavy metals
. Taxonomic analysis of water column and seabed sediment samples
. Mathematical analysis of taxonomic data
. Ecological assessment
. Ecotoxicological testing of environmental samples and industrial chemicals
. Atmospheric monitoring

During the first operational year (to March 1999), the Laboratory has concentrated on implementing a substantial number of analytical methods and procedures to support the above activities.

These methods have all been selected and agreed with Azeri regulators and scientific advisors, with the aim of ensuring that it is possible to monitor the effects of industrial activities to international standards of precision and reliability.

A comprehensive quality assurance system is being developed and implemented, so that all the work carried out within the Laboratory is auditable and verifiable.

In the first operational year, the Laboratory has fully implemented the analytical methods and organisational systems required to carry out comprehensive offshore chemical and biological surveys.

Five such surveys have been Successfully completed and reported, demonstrating that Azerbaijan now has the capability to monitor offshore activities to a standard, which fully matches that, claimed by our international competitors.

During the first year, we have also made a valuable contribution to the evaluation and risk assessment of harbour sediments, wastes, and contaminated soils.

Caspian Specific Ecotoxicology Procedures (CSEP)

A key task during 1998 was the development of a suite of Caspian-Specific Ecotoxicological Procedures.

вышеперечисленных работ.

Эти методы были выбраны и согласованы с Азербайджанскими научными консультантами, с целью оценки промышленного воздействия на экологию по установленным международным стандартам. Система гарантии качества всей проводящейся работы разрабатывается и осуществляется в Лаборатории.

В первый год работы, Лаборатория полностью осуществила выполнение аналитических методов и организационных систем, требующихся для проведения морских химических и биологических исследований.

Пять таких исследований были успешно проведены и описаны в соответствующих отчетах, доказывающих, что Азербайджан имеет полный потенциал для проведения мониторинга операций, проводящихся в море в соответствии со стандартами, способными конкурировать на международном уровне.

В течение первого года, мы также сделали ценный вклад в изучение и оценку риска, связанного с донными отложениями портов, а также отходами, и загрязненными почвами.

Каспийские Специфические Экотоксикологические Процедуры (КСЭП)

Главной задачей в течение 1998 года была разработка ряда Каспийских Специфических Экотоксикологичеких Процедур.

КСЭП

Необходимость этих методов была выявлена Азербайджанскими учеными и регулирующими органами, принимающими во внимание то, что методы проведения тестов, используемые в других странах, не могут быть применены в отношении Каспийского моря, поскольку его бассейн имеет

CSEP

The need for such methods was identified by Azeri scientists and regulators, recognising that foreign test methods might not be appropriate for the Caspian due to its enclosed nature and unique biology and water chemistry.

With substantial and sustained support from Azeri scientists, appropriate test species were selected and laboratory cultures were developed. Once the reliability of the culture systems had been established, a suite of toxicity test methods was implemented.

These include tests with; zooplankton; phytoplankton; sediment dwelling crustacea and molluscs, and fish.

The methods are all written in accordance with international guidelines and standards, but are designed to take specifically into account the requirements of Caspian water chemistry and biology.

закрытую структуру и уникальный биологический и химический состав.

При существенной поддержке Азербайджанских ученых, были отобраны соответствующие виды организмов для проведения тестов, а также созданы лабораторные культуры. После того как система отбора была установлена, началось проведение ряда тестов на токсичность.

Тесты проводились на зоопланктоне, фитопланктоне; ракообразных и моллюсках, живущих на донных отложениях и рыбах.

Созданные методы соответствуют установленным международным стандартам при учете химического и биологического состава Каспийского моря.

Возможно, самым важным достижением Лаборатории является обучение персонала.

Качество полученных результатов было достигнуто благодаря системе управления руководящего состава ERT и Международной Экоэнергетической Академии, а также вкладу регулирующих органов и ученых Баку.

Успех Лаборатории в равной степени стал возможным благодаря азербайджанским сотрудникам и системе образования, подготовившей таких квалифицированных специалистов.

Perhaps the most important achievement of the Laboratory has been in recruitment and training.

The quality of the output of the Laboratory owes a great deal to the management provided by key ERT and IEA staff as well as the scientific and regulatory community in Baku.

Equally our success owes a great deal to the Azeri staff of the Laboratory, and to the educational system which produced such capable graduates and technicians.

* * * * * * *

ENVIRONMENTAL MONITORING OF CASPIAN FIELDS. NEW PARADIGM. NEW SOLUTIONS.

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INTRODUCTION

Environmental monitoring of offshore fields is complex systems of studying, assessing, and forecasting changes in marine ecosystems and their components, which are caused by an operator's industrial activity.

The ultimate goal of environmental monitoring of offshore fields is to minimize the damage done to the marine environment and to rationally organize environmental protection measures. With the toughening of environmental standards, monitoring is becoming an important part of the oil business - determining the profitability of projects and the effectiveness of efforts to protect the environment.

At the same time, an adequate solution of monitoring tasks everywhere runs up against serious difficulties caused by the properties of marine ecosystems as the subjects of research and the lack of a methodology for monitoring which is well-grounded scientifically.

In international practice (the North Sea, the Gulf of Mexico, the Persian Gulf, the US coast, etc.), pragmatic approaches have formed and are widely used, which are based on the methods of experimental hydrotoxicology, comparative faunistics and expert assessments. Oil companies having begun work in the Caspian are, in essence, copying these approaches.

However, there are a number of circumstances making these approaches conceptually incompatible with the region's conditions.

This dictates the need to develop new methods capable of adequately identifying and forecasting the consequences of widespread oil production. Intellectual monitoring opens up real prospects for developing such methods - the possibilities for which are examined below.

1. THE PROBLEMS OF MONITORING CASPIAN FIELDS

Monitoring of the Caspian fields where intensive development has been going on since the 1940s has already long ago demonstrated its low level of effectiveness. The need for moving on to more effective approaches is today linked with the following circumstances:

1.
The appearance of a new hydroecological paradigm over the past decades which fundamentally changes the view on the methodology of studying, assessing and forecasting the consequences of pollution of the marine environment .

2.
The uniqueness and complexity of the environmental situation in the Caspian which demands a maximum consideration of the tenets of the new paradigm which in the conditions of other bodies of water can to one degree or another be ignored. The condition of the Caspian ecosystem is evaluated by specialists to be "serious", "critical", and "catastrophic" .

3.
The anticipated scale of pollution of the sea in connection with the new oil boom. In the greater Caspian region, over the next 30 years 40-60 billion barrels of oil will be produced with an overall investment of up to $300 billion US dollars. The anthropogenic impact in all this will, without question, be a "catastrophic disruption" such as was not encountered before in the history of the sea nor is imprinted upon its "genetic memory."

4.
The serious economical situation in the region and the deep crisis in Caspian ichthyology, which creates favorable ground for all manner of environmental disruptions.

2. THE TASKS OF MONITORING

The group of issues resolved by modern systems of environmental monitoring of offshore fields is quite broad and includes the following tasks:

T1.
Assessment of the original state of the environment of the development area.

T2.
Toxicometry and toxic norm-setting for drilling and operational discharges (oil, oil products, drilling fluids, drilling cut, produced water, etc.). These tasks

are resolved on the basis of "fishing industry" MACs' (Maximum Allowable Concentrations) which are widely accepted in the Former Soviet Republics. The use of "temporary" MACs, which are coordinated with local environmental and fish protection agencies, is widely practiced.

T3.
Calculation of discharges (the composition, volumes, toxicity, and timetables).

T4.
Day-to-day control of hydrological indicators, hydrochemical (quality of water and bottom sediments) and hydrobiological (macrobenthos, plankton, fish, seals) characteristics of the development area.

T5.
Assessment of the impact on the marine environment and forecasting of consequences. These tasks are solved by expert assessment methods using the results from tasks TI-T4.

T6.
Simulation of oil spills during accidents (blowouts, breaks in underwater pipelines, tanker accidents, springs formations, etc.) with the goal of evaluating the risks of polluting critical areas of the sea and coast and planning measures for localizing and eliminating the consequences. This is done with the help of hydrodynamic models and hydrometeorological statistics.

T7.
Normative-legal and informational cooperation with environmental and fish protection agencies and allied systems of monitoring.

The volume and nature of operations associated with solving the enumerated tasks are determined by the conditions in the development area and the monitoring methodology adopted. The latter affects the cost of oil produced and the overall profitability of field development projects today in a decisive manner.

3. A NEW ECOLOGICAL PARADIGM

At present, a new paradigm (system of concepts, principles, laws, ideas, and methodologies) has formed in marine ecology, which fundamentally changes the methodological bases for monitoring. The formation of a new paradigm is to a significant degree also conditioned by new notions in the theory of complex systems, in the theory of experiments and in the theory of knowledge. The set of tenets of the new paradigm is critically important for the environmental monitoring of the offshore Caspian fields and defines the general problematic of monitoring in the coming century. We will note these tenets:

Tenet 1.
The shifting of emphasis in toxicometry and toxic norm-setting (tasks T2-T5) towards the problem of chronic pollution, which is predominant in offshore oil production and which is extremely dangerous for hydrobionts. The latter is linked with the sea's colossal capacity for bio-accumulation, the great vulnerability of its trophic structures, and the narrow adaptive capacity of hydrobionts to their dwelling environment. Imperceptible, hidden, slow-acting chronic pollution leads to irreversible disruptions on the population-genetic level, which (by virtue of the mechanisms of population genetics) appear to a complete degree only after completion of oil development operations.

Geneticists note a real danger of turning the Caspian into a gigantic dumping ground for "genetic waste."

Tenet 2.
A move away from the concept of "fishing industry" MACs widely used in tasks TI, T2, and T7 and a move to the concept of "Ecological Allowable Concentrations" (EAC), which characterize not the potential but the actual threat of oil pollution. EAC, in contrast to the standard fishing industry MACs, must be developed differentially for specific production areas and take into consideration the duration of exposure, the biotic and abiotic factors inherent to the area, their ecological link with external areas of the sea, and synergistic effects. Today, it is generally acknowledged that popular fishing industry MACs, which are easily accepted on the level of mass consciousness, hide within them a great danger by creating the illusion that the delicate environmental problems of the sea can be solved by exclusively technical methods (technology that gives off little waste, purifying facilities, etc.) which is fundamentally incorrect . This also applies fully to "biogeographical" MACs which were examined in the latest Contracts as an alternative (acute experiments on shrimp (US EPA) and animals endemic to the Caspian). The problem of environmental standards, thus, moves into the realm of population toxicology and toxicogenetics.

Tenet 3.
The need to integrate the monitoring activity of oil companies into a Unified System of Monitoring the sea (sector) given the entirely interrelated nature of the Caspian ecosystem and possible interference effects as operations approach wide-scale levels. In Caspian ichthyology, possible scenarios are being discussed for the destruction of the fattening and spawning migration routes, which have formed over time. This is capable of leading to a final undermining of stocks of sturgeon - unique relic ichthyofauna in the Caspian basin, which provides more than 80% of the world catch of this highly valued fish.

Integration is necessary because the principal of "spatial-time location" used today by operators (carrying out environmental monitoring of offshore fields within the boundaries of the Contract Area and at different stages in the development of the field), ignores the great solubility and spreading of toxicants by sea currents and the "memory" effects of the marine environment and it will only describe the pollution that remains.

Tenet 4.
The need to expand the functional structure of environmental monitoring of offshore fields by including such pressing tasks for the region as:

T8.
Early diagnostics of catastrophic conditions of the sea's ecosystem;
T9.
Forecasting of future consequences atoll pollution on the scale of the whole body of water;

T10.
Development of differentiated environmental standards for individual areas of the sea during different periods of development.

T e n e t 5.
Strengthening the practice of environmental monitoring of offshore fields (tasks TI, T2, T5, T7) by using simulation methods to compensate for the limited possibilities of experimental hydrotoxicology and the subjective nature of expert assessments. The shortcomings of expert assessment methods, which are widely used during the stage of interpreting and extrapolating from initial data, are today widely known. These are: the often encountered conservatism of experts and their devotion to orthodox scientific routes; the lack of the necessary range of vision for systemic integration of the results from studies and primary analysis; and the dependence of the decisions that are made on personal, group or corporate interests, particularly in the case of dependent expert evaluations when the work of the experts is paid for by the oil companies. It is understandable how pointless, and in many cases simply illusory, monitoring can be that is based on the "authoritative judgements" of experts. It is also understandable that in the Caspian conditions the practice of using dependent experts can have very negative consequences.

T e n e t 6.
A move to the new strategy of environmental modelling reflecting modern scientific ideas about as design adequate of natural complexes, which experimental verification practical impossible. Among of the main principles of new strategy are as follows:

1)
principle of multiple modeling ("bootstrap principle" (Chew, 1968), "cooperation of models" (Beer, 1976); "principle of three-membership hierarchy" (Patten, 1978); "multimodels" (Nalimov, 1981), "combine model" (Bateson, 1989));

2)
integrity principle (reflecting so circumstance that ecosystems patology are correctly identicated only by intergal analysis of natural and anthropogen dinamics (Beegon et al, 1989; Mejjerin, 1996));

3)
standardization principle (models must be besign on the hierarchy consistency regional standardstest-systems, scales, methodics (Beegon et al, 1989; Holling, 1983));

4)
adaptability principle (it is necessary in the complex, permanently changeable and uncertain environments (Odum, 1983; Beegon et al, 1989; Xolling, 1983));

5)
uncertainty principle (the uncertainty, permanenty characteristic of natural complexes, today finaly destroed the illusive hopes on "large computational models" and "superprecision" ecological statistics; it is necessary a new conceptions and new technologies of environmental modelling taken into account the uncertainty factor; technique of modelling in the uncertain in the cognitive psycology and knowledge engineering is conidered).

Tenets 1-6 reflected key peculiarities of monitoring of offshore fields, its phenomenology. Out of this Tenets the monitoring of offshore fields and environmental management on whole in region are worthless.

4. THE PROSPECTS FOR IMPLEMENTING THE NEW PARADIGM

The tenets of the new paradigm, which were enumerated above, postulate, in essence, the concept of a new generation of monitoring systems. Up until recently, however, the implementation of such systems has remained problematic - reflecting the general crisis of environmental simulation. The situation changed with the appearance of new information technologies based on the ideas of artificial intelligence. Gnoseolocical* experience obtained in this area has freed ecology from the "mathematical-cybernetic illusions" of the 1970s that were generated by successes in computer technology and by a myth-creating mathematical elite. And this experience gave the thrust to the formation of a new trend in applied ecology - intelliqent monitoring, based on the Artificial Intelligence Technology and means of computer sciences

5. THE POSSIBILITIES OF INTELLIGENT MONITORING

The advantages of intelligent systems stem foremost from their practically unlimited possibilities for accumulating theoretical knowledge and human experience (heuristics, empirical techniques and simplifications) for solving the complex, incompletely understood tasks of ecology which do not lend themselves to formalization and strict mathematical analysis. Fundamentally important in this is the fact that intelligent systems provide the ability to quickly adapt the knowledge obtained to a new situation and to new mechanisms in the studied sector. The quality of solutions obtained is achieved not only by the simple accumulation of knowledge, but mostly by incorporating this knowledge into one conceptual model of the subject reflecting the general rules of the structural-functional organization and behavior of subjects in this class. This provides a synergistic effect of competence and robustness ("ecological wisdom") [8] and the possibility of creating computer programs-consultants with a maximum (at the present stage) level of competency, which is not attainable for expert ecologists, nor for traditional model platforms, which are determinate, stochastic, and simulative. Intelligent monitoring, in our view, signifies the new sixth phase in the "Calendar of events" of ecological science (Rozenberg G., 1992). It allows us to move away from the practice of "authoritative judgements"

and take a step in the direction of a scientifically grounded solution of practical questions associated with:

1)
increasing the adequacy and effectiveness of monitoring of individual Contract sites;

2)
creating a Unified System of Monitoring the sea;

3)
carrying out ecological expert evaluations of projects for developing Caspian fields;

4)
implementing a Caspian Environment Programme which is now carriedout by the Caspian coastal states, the Word Bank and the European Community (through the EU/TACIS program) under umbrella of UNDP, UNEP and GEF.

The technology of intelligent monitoring opens up the unique possibility of preserving in a compact and accessible form the enormous empirical experience of local specialists that has been accumulated over decades of practical work, which western specialists lack and which can quickly be irretrievably lost.

CONCLUSION

Intelligent monitoring creates the prerequisites for solving an important problem of Caspian conditions - the problem of the adequacy and effectiveness of environmental monitoring of offshore fields.

An orientation towards traditional approaches, though, will make environmental monitoring of offshore fields more inadequate and excessively expensive.

For over 100 years, the Caspian has been the "testing ground for anthropogenic experimentation". The accumulated mass of facts and knowledge can today be systematized in the form of a compact computer Knowledge Base and used for adequately controlling the anthropogenic impact and at the same time for protecting operators from unfounded suits and international grievances connected with the transborder pollution.

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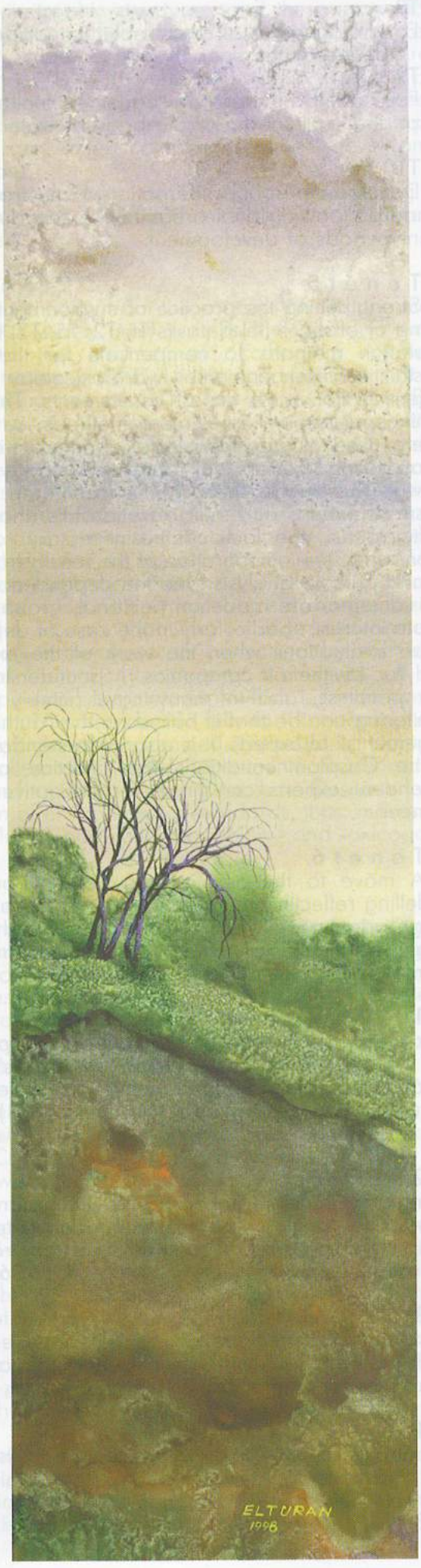
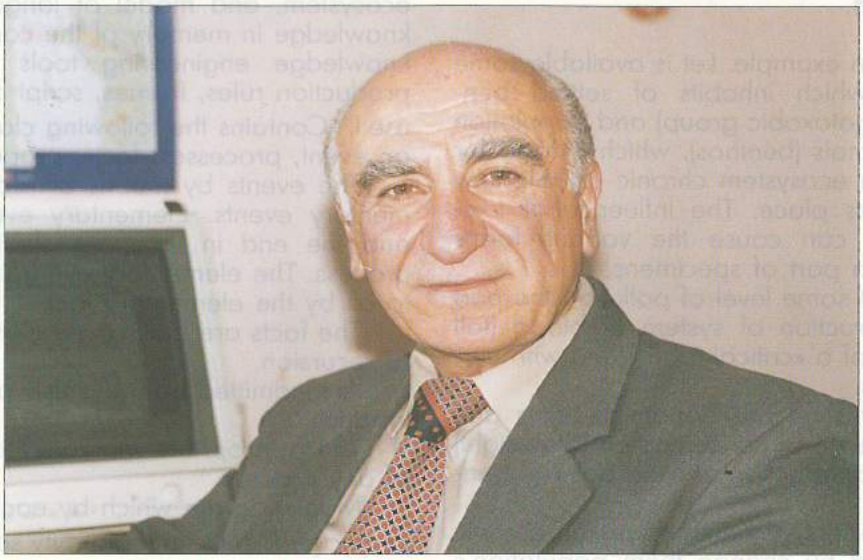


KNOWLEDGE BASED MODELS OF ECOLOGICAL DYNAMICS



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Dr.Karayev R.A., the head a department Institute of Cybernetics of AS Azerbaycan, head of the Ecological Modeling Centre of International Ecoenergy Academy.
Specialist in the field of applied systems analysis and computer sciences.
Since 1986 he is engages in theoretical and applied researches in the artificial intelligence field. Has been a leader of a number of projects of industrial intelligent systems applied at enterprises of Russia, Ukraine and Kazakhstan.
Since 1995 he is working on problem of employment of computer sciences technologies in the applied tasks of Caspian ecology: regional EIA, EIA in transborder context, toxic-standardization of drilling and operating waste, diagnosis of sea pathology, forecast of population dynamics of sturgeon (Russian and Persian herbs) and etc.
Investigation aim is to raise the adequacy and efficiency of environment protection projects in unique and complex conditions of Caspian Sea.
He is a supported of "new ecological paradigm" of Caspian Sea, which realization connected with draw of modern technologies of knowledge and creation of integrated modeling platform for assessment and forecasting of consequences of widely oil extraction, mass poaching and sea transgression.
He has more than 130 scientific works, of which more than 20 in the field of ecology.

The new approach to modeling dynamics of ecological systems, based on artificial intelligence technology (knowledge-based models) is offered. The conceptual circuit, structure and algorithms of work of knowledge-based dynamic models is examined. Their behaviour is investigated at absence / presence disturbance.

Introduction. Numerous attempts of mathematical modeling of ecological systems (Mathematical models in ecology, 1991) not distances practically significant of results. Today it is clear, that known phenomenologic property of natural complexes (Bolshakov V.N. et al, 1993) completely exclude an opportunity of their adequate modeling by means of classical calculus. The new prospects are opened by technology of knowledge bases (Artificial intelligence, 1990). Tool opportunities of technology allow to build models of a new class, answering the modern requirements of the theory of modeling of complex systems (openness, fuzziness, adaptability, emergency, memory, technologity) and approaching ecological practice to the decision of a key problem of ecological modeling - problem of adequacy and efficiency.

In work on an example of centrain water ecosystem general principles and methodology of the offered approach are considered. The conceptual circuit of dynamic model, forming a trajectory of ecosystem behaviour of a sequence of its discretic states, is given. Such peculiarity of models that each of discretic state will be formed by closure of some initial set of the facts and events. The procedure of closure is realized by the inference mechanism, using the current facts and law of behaviour of ecosystem kept in knowledge base. Thus

purely the method of closure has not basic meaning application of several methods is allowed. The area of application of the offered approach - real (non-Marcovian) ecological systems, structure and processes in which characterize by apriori uncertainty and permanent variability.

1. Problem statement.

We shall consider an example. Let is available some water ecosystem, in which inhabits of settled benthofage population (oligotoxobic group) and population of bottom-dwelling animals (benthos), which is food for the benthofages. In the ecosystem chronic pollution by toxical substances takes place. The influence of toxicants on benthofages can cause the various forms pathology (disease) in a part of specimens.

Alongside with it, at some level of pollution the part of specimens has destruction of system of blood (fall hemoglobin ?? below of a «critical level") and with current of time they perish.

Influence of toxicants on the bottom-dwelling animals can bring in decrease of concentration (bioweight) of benthos and, thus, to reduction of food base of benthofages.

The integrated response of benthofages on chronic intoxication is estimated by change them population's characteristics: number, percent ill specimens, average size of specimens, presence / absence of process of reproduction and growth.

Ecosystem's researcher can interest the following problems:

1) Forecast of population's dynamic of benthofages (number, percent ill specimens, and size of specimens);

2) Opportunity (risk) occurrence in population of non linear effects ("catastrophe") owing to synergism of the factors of environment;

3) Conditions, necessary for maintenance for stability of ecosystem at occurrence additional impact (non controllable withdrawal of benthofages, introduction of predators) and etc.

Some parameters of ecosystem (table 1 of the Appendix), usually accessible in monitoring practice, and law of behaviour, used in ecotoxicology researches - the responses of populations on pollution, relation between populations and environment (table 2 of the Appendix) are known also.

The brought example reflects typical statement of a problem of modeling.

2. Modeling methodology.

We shall enter discretic time t:=t, t+1, ..., t+n,...

We shall enter concept of a state S of system on an individual interval of time and concept of a trajectory of system. The trajectory T is a sequence of states of system. Behaviour of system in time we shall simulate, designing and investigating its trajectory. We shall for this purpose use technology of knowledge bases. The conceptual circuit of this model is brought on a figure.

Base concepts of model: a state and trajectory of system, knowledge base and inference mechanism. To give constructive definition of these concepts we shall specify statement of a problem in conformity with cognitive paradigm of knowledge engineering (Anderson, 1983).

Let language $\tilde{L}$ is given which experts (biologists, zoologists, and toxicologists) for the description natural ecosystem, and model of language L, reflecting their knowledge in memory of the computer with the help of knowledge engineering tools (semantic networks, production rules, frames, script and etc.) use.L Contains the following classes of the formulas Φ: an event, processes, facts, properties, laws.

The events by means of recursion are built of elementary events. Elementary event, have a beginning and the end in time, we shall name as elementary process. The elementary event completed in time refers to as by the elementary fact.

The facts are built of the elementary facts by means of recursion.

Are admitted both events - prototypes, and events - instance.

The appropriate markers mark beginning and end of any process.

Map is given which by each of the formulas Φ of language $\tilde{L}$ puts in conformity some design, determined over the appropriate sets-maps from $\tilde{L}$.On set $\tilde{L}$xL the relation $|=$ is determined, i.e. for each pair (Φ,η) there is the way of determination, whether has a place $\eta|=\Phi$ whether or not. We shall note, that considered paradigm assumes openness-principle incompleteness of the description of simulated system.

It means, that set L , especially designs η from $\tilde{L}$, included in an area of definition of relations $\eta|=\Phi$, cannot be considered completely described.

From here follows, that it is necessary to have a way of the instruction, which just elements and the designs from $\tilde{L}$ are available in our disposal. Circumstance that the design is available in system in a considered moment of time, we shall designate through $|=\eta$.

Directly from openness of system follows also, that the reception of a "settlement" trajectory cannot be result of the decision of a problem: the account openness demands, that those factors, which were considered disturbance in a classical case (Nerode et al, 1993), should be considered here as "equal in rights".

3. State and trajectory of system.

As zero approximation we shall believe that a state is set (observable) facts

$$S'=\{\eta||=\eta\}\ \cup\ \{\Phi|\eta|=\Phi\}.$$

Each of state is designed by closure of some inducing set of events. This inducing set consists of the facts (table 1) and axioms (table 2). Among the facts - facts observable and forecasting from the previous state; among axioms - as theoretical, so empirical and heuristic knowledge.

Thus, the work of model begins with construction of a state, which in essence there is the closure of initial set of the facts. Thus a number of processes (conclusion in system of rules and calculation in model) is carried

out, namely those processes, for which already actual parameters "are ready". These processes come to an end at stabilization of designed set. Then to a constructed state rules, starting formation of a nucleus of the following state, are applied, and the process repeats.

Let F - some procedure of closure of set S^1 which can operate both calculations in L, and reasoning in L. Then it is possible to describe iterative process of construction of a state:

1) $S:=S^1$;
2) $S^1 := F(S)$;
3) *Transition to* (1),

Result of which will be a motionless point of the equation

$$F(S) = S \qquad (3.1)$$

We shall name the decision of this equation as a state of system. A trajectory of system (as well as is higher) we shall define as a sequence of its states:

$$T = < S(t), S(t+1), ..., S(t+n), ... >.$$

4. Knowledge base.

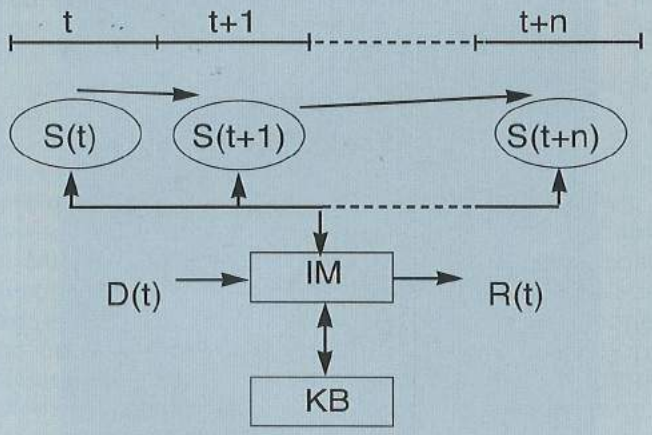

FIG. *CONCEPTUAL SCHEME OF ECOSYSTEM DYNAMIC MODEL.*
S(t)- state of systems on t-th interval time;
KB - knowledge base
IM- inference mechanism
D(t)- monitoring data
R(t)- modeling results

The knowledge base *(KB)* contains the laws of behaviour of system, reflecting statistically the steady relations between population and environment. For representation of knowledge about the laws of behaviour we shall use production rules *<IF....., THEN.....>*, though for this purpose can be used and other formalism.

In conformity with character of the listed above relations we shall consider, that *KB* includes:

B_R - base of rules on set of names and concepts of the events - prototypes and

B_P - base of computing and logic procedures on set of examples of events. These bases are connected among themselves by the relation |=. The knowledge base B_R in turn includes two classes of the relations:

B_{RS} - class of the relations, consisting of rules, which in the list added /removed of events have only events, have markers of a beginning, beginnings equal to markers of events from a condition of rules. The first of these rules (R^S) have the empty list removed of events, second (R^{-S}) - empty list of added events.

Following definitions of logic of time (Iven, 1980) rule R^S and R^{-S} we shall name as rules of synchronous behaviour. Accordingly - procedures of short circuit, based on these rules, we shall name as procedures of synchronous closure (F^S);

B_{RD} - a class of the relations, consisting of rules, which in the list of added events have only events, have markers began of large markers of a beginning of event from a condition of rules.

We shall designate these rules R^d. Following (Iven, 1980), we shall name as their rules dyachronous of behaviour, and appropriate procedures of closure - procedures dyachronous of closure (F^d).

5. Inference mechanism.

The inference mechanism realizes algorithm of management by a conclusion over *KB* at the decision of problems of modeling. In considered model it comes true with the help of procedures F^S and F^d . We shall specify as these procedures work.

The procedure F^S is carried out on each iteration at the decision of the equation $S=F(S)$ for each event X of a current state S'.

The procedure F^d is carried out for each event X of a current state S.

According to established algorithm of an inference we shall specify concept of a state and trajectory of system. We shall consider two cases: at absence and presence disturbance.

6. State and trajectory of system in absence disturbance.

All told means above, that at definition some n-th the state of system are necessary for taking into account the contributions (if those are) functions F^d all previous state and contributions of all such processes are available, marker of a beginning of which there is less number of a considered state, and marker of the end it is more.

We thus have, for n-th state of system

$$S_n = F^S(\cup\{X_{l,m}\} \cup (\cup F^d(S_k)) \qquad (6.1)$$

Where X - processes with markers l and m of a beginning and end accordingly: the first member con-

tribution of all processes with $L \le n$; $m \ge n$; the second member - contribution of all previous condition with $k < n$.

It is obvious, that the trajectory of system is completely determined by system of the equations (6.1), if an initial state so is given and for any state S takes place (5.1), which is in essence a condition of stop.

7. State and trajectory of system at presence disturbance.

Disturbance we shall understand some event (set of events), the occurrence of which in a state S is not result of the decision of system of the equations (6.1).

Let I - some disturbance in a state S_i , *i.e.* $S_i \cup \{I\}$ And takes place $| = I$.

Then the trajectory of system up to a condition S_i is determined by parities (3.1), and for a state S_{i+1} we shall have

$$S_{i+1} = F^s(F^d(F^s(S_i \cup \{ I \}))).$$

8. Steady of system.

The steady is a characteristic, reflecting ability systems to keep a movement on a planned of a trajectory (to support a planned mode functioning), despite influencing on it disturbance. We shall specify concept of a steady trajectory for considered system.

Definition. The trajectory T refers to as steady, if for any state S_i (t) $\in T$ and disturbance Ii

$$F^s(F^d(F^s(S_i))) \subseteq F^s(F^d(F^s(S_i \cup \{ I_i \})))$$

The proposition. If the procedure F^s is monotonous, the trajectory of system is steady.

The p r o o f. By virtue of monotony of a procedure $F^s F^s(S_i) \subseteq F^s(S_i \cup \{ I_i \})$. But, as directly follows from definition F^d (item 5.2), the procedure F^d is also monotonous, therefore

$F^d(F^s(S_i)) \subseteq F^d(F^s(S_i \ I_i))$.

From here follows, that

$F^d(F^s(S_i)) \subseteq F^s F^d(F^s(S_i \ I_i))$.

The proven proposition characterizes a sufficient condition of stability of a trajectory.

The conclusion. In connection with limited volume in work does not consider a number of the important questions of offered technology of modeling: a choice of a step of quantization of time, designing of ecological scales, completeness and noninconsistency of knowledge base, verification of adequacy of model and etc. At the same time the submitted conceptual circuit reflects those principle peculiarities of the approach, which allow advancing in a direction of increase of adequacy and efficiency. Such peculiarities are: (1) opportunity of integration within the framework of uniform model all accessible at the present stage of the forms of knowledge and modeling paradigms, (2) simplicity of adaptation of model to changes and again found out laws of ecosystem, (3) much weaker requirements to formalism, than in mathematical models, opening an opportunity of qualitative modeling of natural complexes in conditions of uncertainty.

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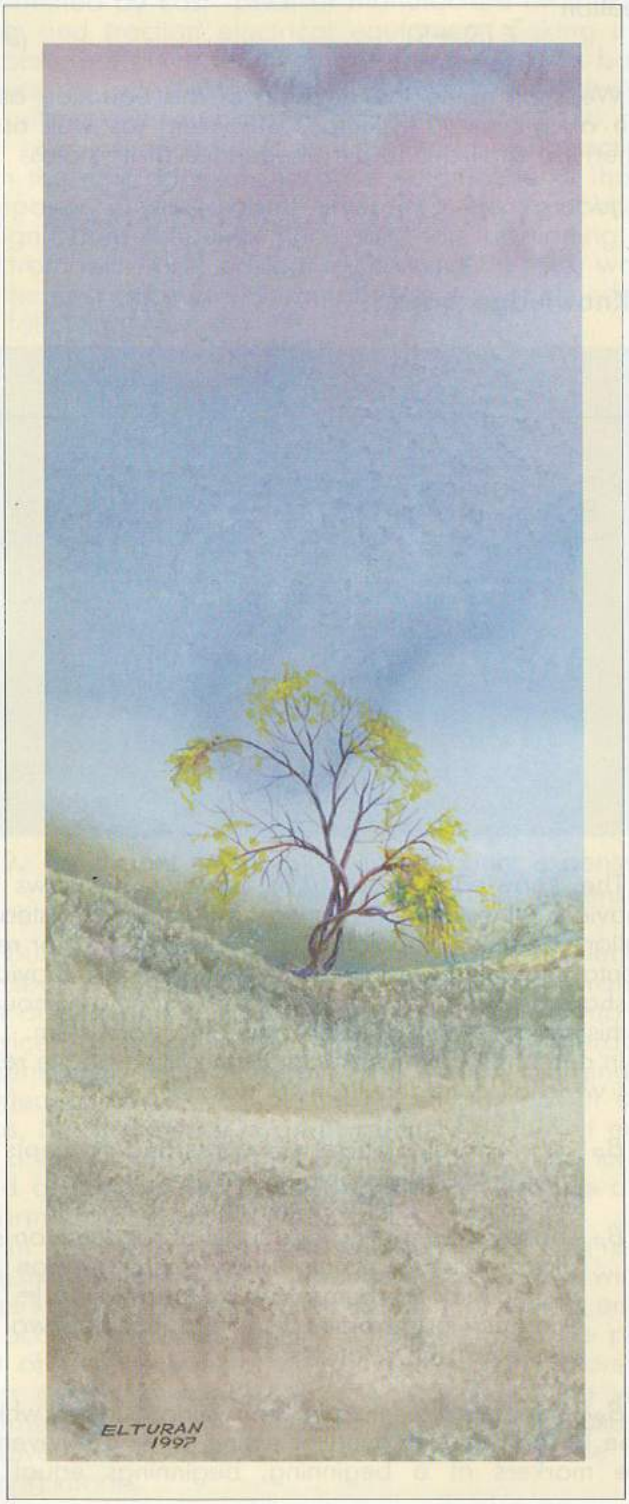

WIND-POWER PLANTS FOR SERVICE OF ELECTRIC TRANSPORT OF FARMS.

ВЕТРОЭНЕРГЕТИЧЕСКИЕ УСТАНОВКИ ДЛЯ ОБСЛУЖИВАНИЯ ЭЛЕКТРОТРАНСПОРТА ФЕРМЕРСКИХ ХОЗЯЙСТВ.

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В сегодняшнем энергобалансе огромная доля принадлежит ископаемому топливу. При получении энергии осуществляется в том или ином виде сжигание различных видов топлива-нефти, газа, угля, дерева-при котором происходит выделение больших количеств углекислого газа, накопление которого в атмосфере ведет к "парниковому эффекту". Уже сейчас это явление начинает ощущаться в масштабах всей планеты: растет средняя температура воздуха и содержание в нём влаги. Последствия этого явления могут быть катастрофическими.

Основным источником загрязнения окружающей среды является автомобильный транспорт. На его долю приходится более 50% от общего загрязнения воздушной среды. Автотранспорт широко распространен и проникает в самые отдаленные уголки республики.

Многие ингредиенты отработавших газов двигателей внутреннего сгорания (ДВС) оказывают вредное воздействие на организм людей, растения, животный мир, а также приводят к порче различных сооружений. Наиболее опасным является ущерб от повышенной заболеваемости населения в районах с повышенным уровнем загрязнения окружающей среды. Самыми вредными веществами, выбрасываемыми в атмосферу автотранспортом, являются: оксид углерода (CO), оксид азота (NO), сернистый ангидрид (SO) и пыль.

Уровень загрязнения атмосферы (β) можно определить согласно выражению:

$$\beta = \frac{Cco}{ПДКco} + \frac{CNo}{ПДК_{NO}} + \frac{Cso}{ПДКso} + \frac{Cп}{ПДКп}, \qquad (1)$$

Где Ссо , С NO , С so ,Сп -средние годовые концентрации в атмосфере соответственно: CO, NO, SO, пыли (мг/м); ПДКсо ПДКNo ПДКso ПДКп-предельно допустимые концентрации перечисленных веществ в воздухе (мг/м^3).

В связи с вышесказанным, для решения экологических проблем, следует уделять большое внимание вопросам использования *возобновляемых источников энергии, то есть* энергии солнца, океанов, ветра и т.д.

В настоящей работе предлагается комплекс

In today's power balance the huge part belongs to mineral fuel. For reception of energy the burning of various kinds of fuel-oil, gas, coal and wood is carried out which is the cause of evolving of a big quantity of carbon dioxide. Accumulation of this gas in an atmosphere conducts to "greenhouse effect". Today this phenomenon begins to be felt in scales of all planet: average temperature of air and level of a moisture in it grows. The consequences of this phenomenon can be catastrophic.

The basic source of pollution of environment is the motor transport. Its share is more than 50% from all pollution of air. Motor transport is widely-spread and penetrate in most distant places of republic. Many ingredients of utilized gases of internal-combustion engines (ICE) have very injurious effect on people's health, plants, fauna and also are the cause of different buildings' damage . The damage from high level of population's sick rate in regions with increased pollution of environment is most dangerous.

The most harmful substances, evolved into atmosphere by motor transport are: carbon monoxide (CO), nitrogen monoxide (NO), sulphur monoxide (SO) and dust.

The level of atmosphere's pollution β one can define according to formula:

$$\beta = \frac{Cco}{EACco} + \frac{CNo}{EAC_{NO}} + \frac{Cso}{EACso} + \frac{Cd}{EAC_d}, \qquad (1)$$

where: Cco; CNO ; Cso; C_d-average annual concentrations in atmosphere accordingly of CO, NO, SO and dust (mg/m^3);

EACco; EACNo; EACso; EAC$_d$-extreme allowable concentration of the listed substances in air (mg/m^3).

In connection with above-mentioned, for solving of ecological problems it is necessary to spare a considerable attention to questions of using of renewable sources of energy, that is- energy of the sun, oceans, wind etc.

In the present work the complex of measures for creation of ecologically clean zone in agricultural regions is suggested. It is necessary to replace motor transport used in an agriculture into electric transport. First of all it is machines for cultivation of soil and for

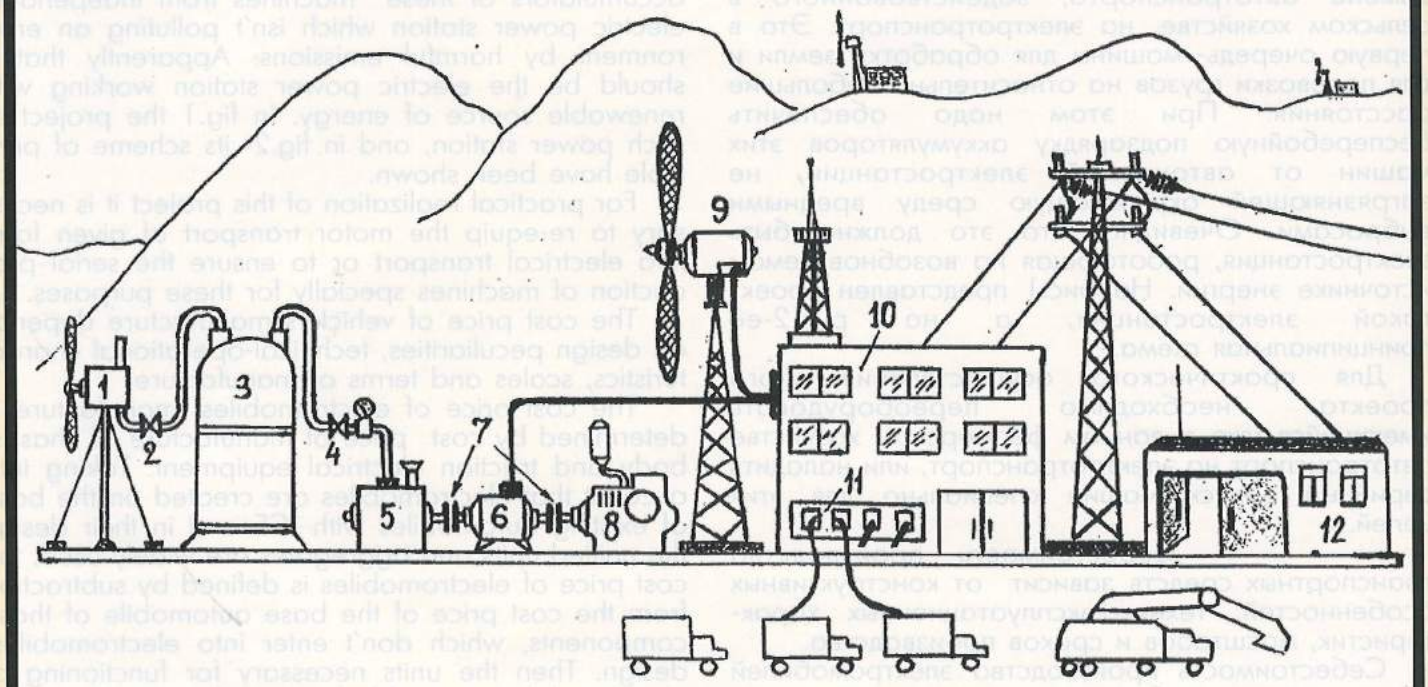

Рис.1 Специализированная ветроэлектростанция

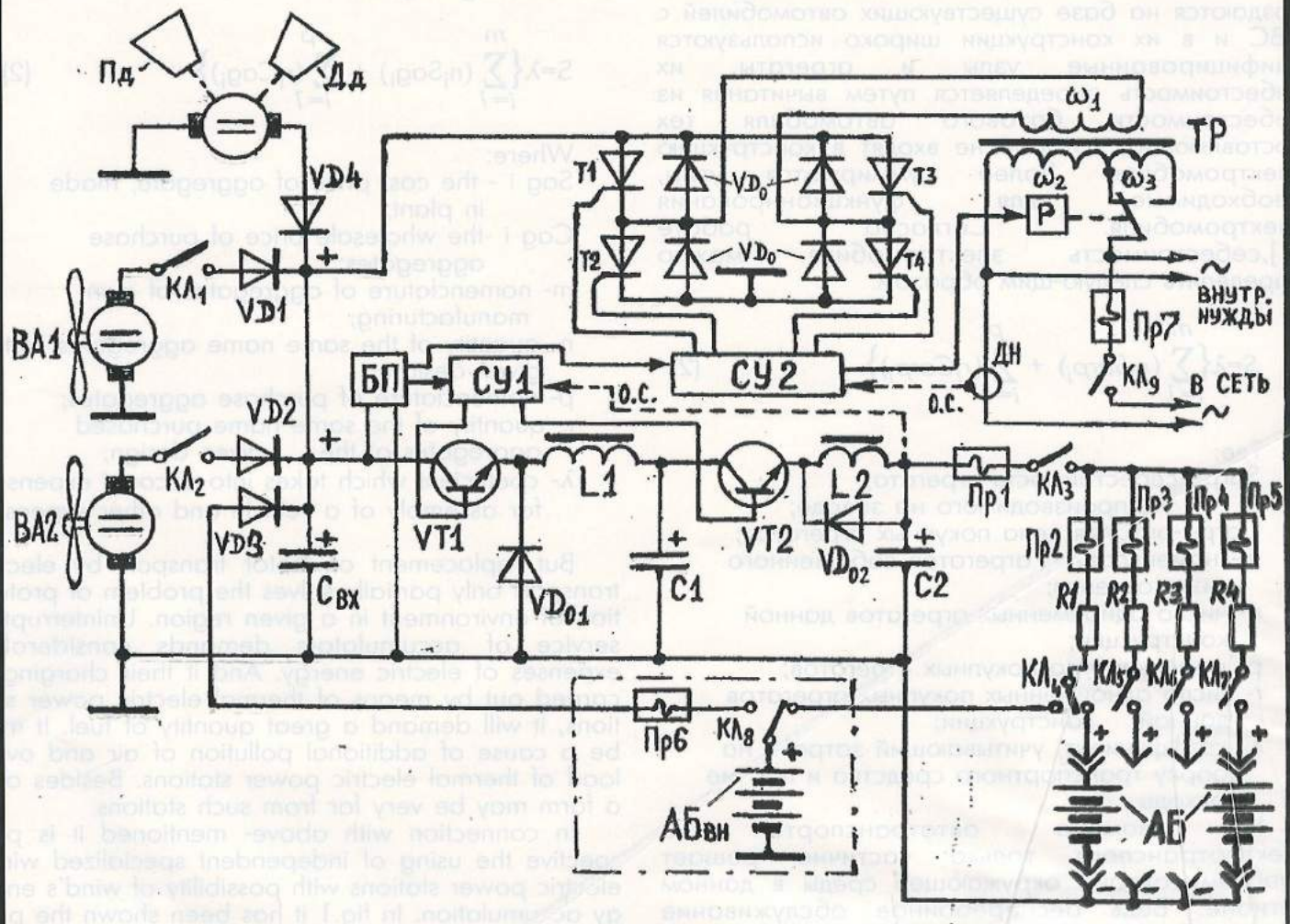

Рис.2 Принципиальная схема ветроэлектростанции

мер для создания экологически чистой зоны в сельскохозяйственных регионах. Речь идет о замене автотранспорта, задействованного в сельском хозяйстве, на электротранспорт. Это в первую очередь- машины для обработки земли и для перевозки грузов на относительно небольшие расстояния. При этом надо обеспечить бесперебойную подзарядку аккумуляторов этих машин от автономной электростанции, не загрязняющей окружающую среду вредными выбросами. Очевидно, что это должна быть электростанция, работающая на возобновляемом источнике энергии. На рис.1 представлен проект такой электростанции, а на рис.2-её принципиальная схема.

Для практического осуществления этого проекта, необходимо переоборудовать имеющийся уже в данном фермерском хозяйстве автотранспорт на электротранспорт, или наладить серийный выпуск машин специально для этих целей.

Себестоимость производства транспортных средств зависит от конструктивных особенностей, технико-эксплуатационных характеристик, масштабов и сроков производства.

Себестоимость производства электромобилей определяется себестоимостью производства шасси, кузова и тягового электрооборудования. Учитывая, что электромобили, как правило, создаются на базе существующих автомобилей с ДВС и в их конструкции широко используются унифицированные узлы и агрегаты, их себестоимость определяется путем вычитания из себестоимости базового автомобиля тех составляющих, которые не входят в конструкцию электромобиля. Далее суммируются узлы, необходимые для функционирования электромобиля. Согласно работе [1],себестоимость электромобиля можно определить следую-щим образом:

$$S=\lambda\left\{\sum_{i=1}^{m}(n_i Sarp_i)+\sum_{i=1}^{p}(r_i Carp_i)\right\} \qquad (2)$$

Где:
$Sarp_i$ -себестоимость агрегата, производимого на заводе;
$Carp_i$ -оптовая цена покупных агрегатов;
m- номенклатура агрегатов собственного изготовления;
n- число одноименных агрегатов данной конструкции;
p- номенклатура покупных агрегатов;
r- число одноименных покупных агрегатов данной конструкции;
λ- коэффициент, учитывающий затраты на сборку транспортного средства и прочие расходы.

Но замена автотранспорта на электротранспорт только частично решает проблему охраны окружающей среды в данном регионе. Ведь бесперебойное обслуживание аккумуляторных батарей требует значительных затрат электроэнергии. И если зарядку их производить от тепловых электростанций, то это потребует сжигания большого количества топлива, что в свою очередь, приведет к дополнительному

transportation of cargoes on short distances.

It is necessary to ensure uninterrupted charging of accumulators of these machines from independent electric power station which isn't polluting an environment by harmful emissions. Apparently that it should be the electric power station working with renewable source of energy. In fig.1 the project of such power station, and in fig.2- its scheme of principle have been shown.

For practical realization of this project it is necessary to re-equip the motor transport of given farm into electrical transport or to ensure the serial production of machines specially for these purposes.

The cost price of vehicle's manufacture depends on design peculiarities, technical-operational characteristics, scales and terms of manufacture.

The cost price of electromobiles' manufacture is determined by cost price of manufacture of chassis, body and traction electrical equipment. Taking into account that electromobiles are created on the base of existing automobiles with ICE and in their design the unified units and aggregates are widely used, the cost price of electromobiles is defined by subtraction from the cost price of the base automobile of those components, which don't enter into electromobiles' design. Then the units necessary for functioning of electromobile are added. According to the work [1],the cost price of electromobile may be defined by the following way:

$$S=\lambda\left\{\sum_{i=1}^{m}(n_i Sag_i)+\sum_{i=1}^{p}(r_i Cag_i)\right\} \qquad (2)$$

Where:
Sag i - the cost price of aggregate, made in plant;
Cag i -the wholesale price of purchase aggregates;
m- nomenclature of aggregates of own manufacturing;
n- quantity of the same name aggregates of the given design;
p- nomenclature of purchase aggregates;
r- quantity of the same name purchased aggregates of the given design;
λ- coefficient which takes into account expenses for assembly of a vehicle and other expenses.

But replacement of motor transport by electric transport only partially solves the problem of protection of environment in a given region. Uninterrupted service of accumulators demands considerable expenses of electric energy. And if their charging is carried out by means of thermal electric power stations, it will demand a great quantity of fuel. It may be a cause of additional pollution of air and overload of thermal electric power stations. Besides of it a farm may be very far from such stations.

In connection with above- mentioned it is perspective the using of independent specialized wind-electric power stations with possibility of wind's energy accumulation. In fig.1 it has been shown the project of such station for charging of accumulators of farm electric transport and also for providing with alternating current (220 V, 50 Hz) of dwelling houses of given farm. In fig.1 it has been adopted the following marks:

загрязнению воздуха и перегрузке тепловых станций. Кроме того, фермерское хозяйство может оказаться на значительном удалении от таких станций.

В связи с этим перспективно применение автономных специали-зированных ветроэлектростанций с возможностью аккумулирования энергии ветра. На рис.1 показан проект такой станции, предназначенной для зарядки аккумуляторов сельского электротранспорта и для обеспечения переменным током 220 В, 50 Гц жилых домов данного фермерского хозяйства. На рисунке приняты следующие обозначения:

1-вспомогательная ветроустановка с компрессором;
2-впускной клапан;
3-ёмкость для хранения сжатого воздуха;
4-выпускной клапан;
5-пневмодвигатель;
6-генератор постоянного тока;
7-фрикционно-зубчатые муфты;
8-дизельный двигатель;
9-основная ветроустановка с генератором постоянного тока;
10-здание электростанции;
11-токосъемники для зарядки аккумуляторов электротранспорта;
12-мастерская для ремонта аккумуляторов и машин.

Затраты электроэнергии при зарядке аккумулятора могут быть рассчитаны следующим образом:

$$Э = \frac{Ц_Э \cdot e \cdot \gamma}{\eta_{э.у.}} \cdot T_Ц \cdot G_Б \qquad (3)$$

Где:

$Ц_Э$ - цена 1 кВт ч электроэнергии(манат/кВт ч);
$\eta_{э.у}$ -КПД зарядного устройства;
γ - коэффициент, учитывающий степень разряда аккумулятора,
e- удельная энергоемкость аккумулятора (квт ч/кг; Вт ч/кг),
$T_Ц$ - количество циклов работы аккумулятора,
$G_Б$ - зависимость массы источника тока от т ребуемого запаса хода электротранспорта.

Электростанция работает следующим образом. Основная ветро-установка 9 вырабатывает постоянный ток, который подается в здание электростанции 10, где производится стабилизация напряжения постоянного тока, преобразование постоянного тока в переменный с фиксированной частотой 50 Гц и напряжением 220 В, измерение и контроль всех параметров электроэнергии. В зависи-мости от мощности электростанции, могут быть применены несколько основных ветроустановок 9. Стабилизированное напряжение постоянного тока выводится на токосъемники 11, с помощью которых производится зарядка аккумуляторов электротранспорта.

1- auxiliary wind- power plant with compressor;
2- input valve;
3- reservoir for keeping of compressed air;
4- output valve;
5- pneumatic engine;
6- direct current generator;
7- friction- cogged muff;
8- Diesel engine;
9- the main wind- power plant with direct current generator;
10-building of electric- power station;
11-contacts for charging of accumulators of electric transport;
12-workshop for repair of accumulators and machines.

The expenditure of electric energy when charging an accumulator may be defined by the following way:

$$EX = \frac{P \cdot e \cdot \gamma}{\eta} \cdot C \cdot \lambda \qquad (3)$$

where:
P -price of 1 kW h of electrical energy (manat/kW h);
η - the efficiency of charging equipment;
γ-the coefficient taking into account the degree of accumulator's discharging;
e- specific energy-capacitance of accumulator (kW h/Kg; W h/Kg;);
C- quantity of cycles of accumulator's work;
λ-dependence of accumulator's weight from the necessary stock of electric transport's motion.

Electric-power station works by the following way. The main wind- power aggregate 9 produces the direct current which is given into the building of electric-power station 10, where stabilization of direct current's voltage and converting of direct current into alternating current are carried out. Measuring and control of all parameters of electric energy also is carried out there. In dependence on the power of electric-power station it may be used several main wind-power plants 9. Stabilized voltage of direct current is given on the contacts 11, by means of which charging of electric transport's accumulators is carried out.

The alternating current is given into the electric line for service of farm's dwelling houses, and also for internal needs of electric power station and workshop 12 is used. Short distances of electric energy's transmission, absence of industrial objects, relatively a little quantity of served houses give a possibility to carry out the electric line one-phase. For cases of wind energy's interrupting the triple protection is foreseed:

1) In the case of transitory absence of wind, supply of dwelling houses by electricity and service of electric transport is finished. But functioning of internal apparatus, lighting, and official radio-station is continued owing to the presence of emergency accumulator.

2) In the case of relatively long absence of wind, the emergency energy block is switched on. The direct current generator 6 is set in motion by pneumatic engine 5, connecting with it by means of muff 7. Muff 7, connecting generator with Diesel engine 8

Переменный ток выводится на линии электропередачи для обслуживания жилых домов фермерского хозяйства, а также используется для внутренних нужд электростанции и мастерской 12.

Небольшие расстояния передачи энергии, отсутствие промышленных объектов, относительно небольшое количество обслуживаемых домов, позволяет выполнить линию электропередачи однофазной.

Для случаев провала ветровой энергии предусмотрено тройное резервирование :

1) При кратковременном безветрии, электроснабжение жилых домов и обслуживание электротранспорта прекращается. Но функционирование внутренней аппаратуры, освещения и служебной радиостанции продолжается, благодаря наличию аварийной аккумуляторной батареи.

2) При относительно продолжительном безветрии, включается резервный энергоблок. При этом генератор постоянного тока 6 приводится в движение пневмодвигателем 5, соединяясь с ним одной из муфт 7. Муфта 7, соединяющая генератор с дизельным двигателем 8 отключена. Пневмодвигатель 5 питается сжатым воздухом из емкости 3, аккумулированным ранее при наличии ветра с помощью компрессора вспомогательной ветроустановки 1. В этом режиме осуществляется обслуживание электротранспорта и энергоснабжение жилых домов.

3) В случае же длительного безветрия, когда ресурсы сжатого воздуха исчерпываются, муфта 7, соединяющая пневмодвигатель 5 с генератором 6, отключается и включается муфта, соединяющая генератор с дизельным двигателем 8.В этом режиме, станция может работать продолжительное время до появления ветра. Дизельный двигатель снабжен устройством для снижения токсичности выхлоп-ных газов.

На рис.2 показана принципиальная схема ветроэлектростанции.

Напряжения генераторов постоянного тока ветроагрегатов ВА1 и ВА2 через раздельные диоды VD1 и VD2 ,поступают на входной конденсатор Свх широтно-импульсного регулятора (ШИР) специального назначения (защищено А. с. СССР №1649625). ШИР стабилизирует постоянное напряжение и исключает его рост и выбросы при сбросах нагрузки, то есть при отключениях аккумуляторных батарей электротранспорта от токосъемников. Это очень важно, так как при очередной зарядке аккумуляторов недопустимы перенапряжения на токосъемниках.

Силовой транзистор VT1 регулятора работает на высокой частоте.Импульсное напряжение поступает на вход фильтра L1C1 и далее отфильтрованное напряжение через отпертый транзистор VT2 и дроссель L2, поступает на обкладки конденсатора С2. Элементы L2C2 еще больше подавляют пульсации выходного напряжения. Обратный диод VD_{01} необходим для замыкания реактивного тока в паузах между импульсами напряжения. С выхода ШИР напряжение через плавкий предохранитель Пр1, is disconnected. Pneumatic engine 5 is fed by compressed air from reservoir 3, which had been accumulated before by means of compressor of auxiliary wind-power plant 1.In this duty it is carried out the service of electric transport and supply of dwelling houses by electricity.

3) If it takes place the long absence of wind, when resources of compressed air is exhausted, the muff 7, connecting pneumatic engine 5 with the generator 6 is disconnected and it is switched on the muff, connecting generator with the Diesel engine 8.In this duty, the station is able to work for a long time until the wind appears. The Diesel engine has been supply with device for lowering of toxic ingredients of waste gases.

In the fig.2 the scheme of principle of wind-electric power station has been shown.

The voltages of direct current generators of wind-aggregates WA1 and WA2 through the separating diodes VD1 and VD2 are given to the input capacitor Cin of width-impulse voltage regulator (WIVR). This WIVR had been created for special purposes (author certificate of USSR №1649625). The WIVR stabilizes the direct current and prevents its increasing and blips when a load is disconnected, that is when accumulators of electric transport are disconnected from the contacts. This is very important because when accumulators are connected for the next charging the excess voltages on the contacts are inadmissible.

Powerful transistor VT1 of regulator works on a high frequency. The impulse voltage is given to the input of filter L1C1 and then the filtered voltage, through the opened transistor VT2 and choke L2, is given to the capacitor C2. The elements L2C2 smooth still more the output voltage's ripples. Reversed diode VD_{01} is necessary for passage of reactive current in the pauses between the voltage impulses. From the output of WIVR the voltage, through the fusible guard FG1, breaker B3, fusible guards FG2-FG5, resistors R1-R4 and breakers B_4-B_7,is given to the contacts to which the accumulators AC of electric transport are connected for charging. When the load is connected, transistor VT2 is completely opened. When accumulators AC are disconnected, it takes place the voltage blip on the capacitor C1 of WIVR because of an energy, accumulated in choke L1. But as soon as voltage on the capacitor C1 begins to increase, deflexioning from the necessary level, transistor VT2 is switched off, preventing feed of superfluous energy to capacitor C2. Capacitor C2fixes the level of voltage acted before.

When accumulators AC are connected again with the contacts for the next charging, transistor VT2 is opened, connecting capacitor C2 with capacitor C1. The difference between voltages is suppressed by the choke L2. So the protection of accumulators of electric transport from excess voltages when commutating of them is provided. All processes in WIVR are controlled by operation system OS1 by means of feedback f.b. Operation system OS1 is fed by power unit PU. Emergency accumulator EA is charged through the breakers B_8 and B_4 and discharges through the breaker B_8, fusible guard FG6 and separating diode VD3 when it is necessary. The operation system OS2 of inverter also is fed by power unit PU. Feedback signal from the voltage pickup VP of

ключ КЛ3, предохранители Пр2-Пр5, токоограничивающие зарядные резисторы R1-R4 и ключи КЛ4 - КЛ7 , поступает на токосъемники, куда подключаются на подзарядку аккумуляторные батареи АБ электротранспорта. Когда есть нагрузка, транзистор VT2 полностью отперт. При отключении АБ, происходит выброс напряжения на конденсаторе С1 ШИР, обусловленный энергией, накопленной в дросселе L1. Но как только напряжение на С1 начинает повы-шаться, отклоняясь от установленного значения, транзистор VT2 запирается, предотвращая подвод излишней энергии к конденсатору С2, на котором фиксируется ранее действовавшее значение напряжения. При очередном подключении АБ на зарядку, транзистор VT2 отпирается, подключая конденсатор С2 к конденсатору С1. Разность напряжений подавляется дросселем L2. Так обеспечивается защита аккумуляторов электротранспорта от перенапряжений при коммутациях. Все процессы в ШИР контролирует система управления СУ1 с помощью обратной связи о.с. Питается СУ1 от блока питания БП. Резервный аккумулятор Абвн заряжается через ключи КЛ8 и КЛ4, а разряжается через КЛ8, предохранитель Пр6 и разделительный диод VD3 в аварийных ситуациях. От БП питается также система управления инвертором напряжения СУ2. В СУ2 также поступает сигнал о.с. с датчика напряжения ДН линии электропередачи. Инвертор состоит из тиристоров Т1-Т4 и обратных диодов VD0 . Выход инвертора подключен к первичной обмотке (W1) трансформатора ТР. Вторичная обмотка состоит из основной(W2) и дополнительной (W3) обмоток. Мощное реле Р, управляемое с помощью СУ2 ком-мутирует отводы вторичной обмотки трансформатора с целью дополнительной стабилизации напряжения. При номинальном напряжении 220 В, контакт реле включен как показано на рис.2. При этом напряжение обмотки W2 передается в линию электропередачи через предохранитель ПР7 и ключ КЛ9. Переменный ток для внутренних нужд станции отводится от трансформатора непосредственно, минуя ПР7 и КЛ9.

Снижение скорости ветра ведет к снижению выходного напряжения инвертора. При снижении напряжения более 20%, СУ2 включает реле Р, в результате чего контакт реле замыкается на крайний вывод обмотки W3, образуя последовательное соединение обмоток: W2+W3 ,что ведет к повышению напряжения в сети. При увеличении скорости ветра, реле переключается в прежнее положение, предотвращая перенапряжение в сети. К общей положительной шине также подключен, через диод VD4 резервный энергоблок, состоящий из генератора постоянного тока, пневмодвигателя Пд и дизельного двигателя Дд.

Применение ШИР в зарядных системах весьма перспективно. Но имея высокий КПД (до 98% и выше), высокое быстродействие в процессе стабилизации, отличные регулировочные характеристики, небольшие массу и габариты, импульсные регуляторы имеют не очень хорошие динамические характеристики при коммутациях нагрузки. Это выражается в значительных выбросах напряжения при сбросах и набросах

electric line comes to operation system OS2. Inverter consists of thyristors T1-T4 and reversed diodes VD0. Output of inverter connected with the first winding W1 of transformer TR. The second winding consists of the main (W2) and additional (W3) windings. Powerful relay RL, controlled by means of OS2, commutates the offsets of second winding of transformer with the purpose of additional voltage stabilization. If the nominal level of voltage is 220V, the contact of relay had switched on as it has been shown in fig.2. The voltage of winding (W2) is given into electric line through the fusible guard FG7 and breaker B9.The alternating current for internal needs of station is taken off transformer directly eluding FG7 and B9.

Lowering of wind's speed causes the lowering of inverter's output voltage. When the voltage is decreased more than 20%, OS2 switches on the relay RL and its contact is switched to extreme offset of the winding (W3). It is formed the series junction of windings: W2+W3 and the voltage in line is increased. When the wind's speed is increased, the relay is switched in its previous position, preventing the excess voltage in the line. The emergency energy unit which consists of the direct current generator, pneumatic engine PE and Diesel engine DE, has connected to the common positive cable through the diode VD4.

Using of WIVR in charging systems is very perspective. But having a high efficiency (more than 98%),high quick-acting of voltage stabilization, excellent characteristics of regulation, small weight and dimensions, impulse regulators haven't good dynamical characteristics when commutating the load. This manifests itself in considerable voltage blips when a load is connected and disconnected. This is inadmissible for charging of accumulators. The voltage blip depends on several factors, one of which is the level of load's current acted before disconnection of load. The more had been the current, the more will be a voltage blip when a load is disconnected.

The new scheme of WIVR, used in the system of wind-electric power station (fig.2) completely solves this problem, ensuring the constancy of voltage on contacts when accumulators AC of electric transport are connected and disconnected.

For example, when the nickel-zink accumulator (type:84НЦ-125-У2) is charged, it takes place the following current-making reaction:

$$Zn+2NiOOH+2KOH \underset{\text{charging}}{\overset{\text{discharging}}{\Longleftrightarrow}} K_2ZnO_2+2Ni(OH)_2 \quad (4)$$

The accumulator's voltage is 135V and the charging current is 20A. Taking into account that a few accumulators can be charged simultaneously the value of charging current may be very considerable.

The amplitude of blip of WIVR's open-circuit voltage when disconnecting the accumulators is determined by the following way:

$$\Delta U_{max} = \frac{\Delta I_L}{C1} t_{LAGmax} + \Delta I^2_L \frac{L1}{2U_{IN} \cdot \Delta\gamma \cdot C1} \quad (5)$$

Where:

ΔI_L - difference of currents when commutating a load;

нагрузки, что неприемлемо для зарядки аккумуляторных батарей. Выброс напряжения зависит от ряда факторов, одним из которых является действовавшее до сброса значение тока нагрузки. Чем больше был ток, тем больше будет выброс напряжения при сбросе нагрузки.

Новая схема ШИР, примененная в системе ветроэлектростанции (рис.2) полностью решает эту проблему, обеспечивая неизменность напряжения на токосъемниках при отключениях и подключениях АБ электротранспорта.

Например, при зарядке никель-цинкового аккумулятора типа 84 НЦ-125-У2 токообразующая реакция выглядит так:

$$Zn+2NiOOH+2KOH \underset{заряб}{\overset{разряб}{\Longleftrightarrow}} K_2ZnO_2+2Ni(OH)_2 \quad (4)$$

При напряжении 135В, ток заряда составляет 20А. Учитывая, что одновременно могут заряжаться несколько батарей, значение зарядного тока может быть достаточно большим.

Амплитуда выброса свободного напряжения ШИР при отключении аккумуляторов определяется следующим выражением:

$$\Delta U_{max} = \frac{\Delta I_H}{C1} t_{3max} + \Delta I^2_H \frac{L1}{2U_{ип} \cdot \Delta K_{зап} \cdot C1} \quad (5)$$

Где:

ΔI_H - перепад токов при коммутации нагрузки;

t_{3max} - максимальное время запаздывания электронного тракта СУ1

$U_{ип}$ - напряжение питания ШИР;

$\Delta K_{зап}$ - изменение коэффициента заполнения $K_{зап}$;

$$K_{зап} = \frac{t_и}{T},$$

(где: $t_и$ - длина импульса напряжения ШИР; T-период следования импульсов).

В новом ШИР выбросы напряжения с амплитудой ΔU_{max} имеют место только на конденсаторе С1. На конденсаторе С2 напряжение при коммутациях нагрузки неизменно, что свидетельствует о повы-шенной устойчивости ШИР. Это подтверждается лабораторными исследованиями на физической и математической моделях и расчетами устойчивости по критерию Гурвица при различных параметрах схемы.

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t_{LAGmax} - maximum lag time of electronical circuit of operation system OS1;

U_{IN} - input voltage of WIVR;

$\Delta\gamma$ - changing of duty cycle: γ ;

$\gamma = t_i/T$ (where: t_i-width of voltage impulse of WIVR; T-period of impulses).

In the new WIVR voltage blips with amplitude ΔU_{max} take place only on the capacitor C1. On the capacitor C2 a voltage is constant when commutating a load. This testifies about high stability of WIVR. This is confirmed by laboratory researches with physical and mathematicalmodels and by calculations of stability with different parameters of circuit according to Gurviz criterion.

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ВЕТРОЭНЕРГЕТИЧЕСКИЕ УСТАНОВКИ ДЛЯ ОБСЛУЖИВАНИЯ ЭЛЕКТРОТРАНСПОРТА ФЕРМЕРСКИХ ХОЗЯЙСТВ.

АННОТАЦИЯ.

В статье рассматривается проблема загрязнения окружающей среды автомобильным транспортом и тепловыми электростанциями. Предлагается комплекс мер для создания экологически чистой зоны в сельскохозяйственных регионах. Показана перспективность применения электротранспорта для сельскохозяйственных работ и одновременно экологически чистых электростанций для обслуживания этих машин и обеспечения электроэнергией населенных пунктов. Предлагается схема такой электростанции.

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WIND-POWER PLANTS FOR SERVICE OF ELEC TRIC TRANSPORT FOR FARMS.

ABSTRACT.

In this article the problem of soiling of environment by automobile transport and thermal electric-power stations is considered. It is suggested the complex of measures for creation of ecological clean zone in agricultural regions.

It has been shown the perspective of using of electric transport for agricultural works and in the same time the using of ecological clean electric-power stations for service of these machines and for providing with electrical energy the populated points. The scheme of such station is suggested.

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ФЕРМЕР ТЯСЯРРЦФАТЫНДА ЕЛЕКТРИК НЯГЛИЙЙАТЫНА ХИДМЯТ ЕДИЛМЯСИ ЦЧЦН КЦЛЯК-ЕНЕРЖИ ГУРЬУЛАРЫ.

ХЦЛАСЯ.

Мягалядя ятраф мццитин автомобил няглиййаты вя истилик електрик стансийалары тяряфиндян чирклянмяси проблеми арашдырылыр. Кянд тясяррцфаты реэионларында еколоэи тямиз зонасы йарадылмасы цчцн тядбирляр комплекси тяклиф олунур.

Кянд тясяррцфаты ишляри цчцн електрик няглиййатынын вя ейни заманда бу машынлара хидмят едилмяси цчцн вя йашайыш мянтягялярини електрик енержиси иля тя'мин едилмяси цчцн еколоэи тямиз електрик стансийаларынын истифадяси перспективлилики эюстярилиб.Беля стансийанын схеми тяклиф олунур.