Appendix A: Location Map of Pipeline Oil Spills in FSU

A1.1 The map shows the location of all the spills in FSU used in this study. Each accident is indicated with a unique number corresponding to the numbers given in ection B.3 of Appendix B. Please note that the location of each oil spill is based on latitude and longitude figures that were derived from the geographical information provided by the sources of the spill data. Invariably, the map locations are approximated and may differ slightly from the exact ground locations.

Appendix B: Characteristics of the 113 Oil Spill Occurrences of FSU

Introduction

B1.1 Several relevant, publicly available sources were consulted for information about crude oil spills from pipelines in the former Soviet Union (FSU). This appendix documents the ***113 crude oil spill accidents*** identified from 1986 to 1996 (inclusive) through detailed accident descriptions (section B3) and summary statistics (section B2). A color map in Appendix A shows the approximate geographical location of these spills.

Data sources

B1.2 The main sources of information for this study are the following:

- Oil Spill Intelligence Report Database (OSIR); Oil Spill Intelligence
- Report, United States.
- Lloyd's Casualty Report (LCR), London, United Kingdom
- Hazardous Cargo Bulletin (HCB), United States.
- Oil and Gas Journal (OGJ), United States.
- Major Hazard Incident Data Service Database (MHIDAS); Health and Safety Executive (owner)/AEA Technology (operator), United Kingdom.
- Institution of Chemical Engineers Accident Database (IChemE); Institution of Chemical Engineers, United Kingdom.
- Ministry on Emergency Situations and Mitigation of the Results of Catastrophes (MChS), Moscow, Russia. Oil Spill Accidents in the Russian Federation 1993.(Translated from Russian).

B1.3 It is important to emphasize that no detailed investigation of single accidents was performed to obtain further information beyond what is directly reported in the sources listed above. In addition to the 7 sources listed above, other sources such as TNO's (Holland) database FACTS and JRC's (Italy) database CHEMAX. However, the information contained therein was either not available for "third parties" or did not cover the FSU area, or was prohibitively expensive without requesting specific data. Furthermore, possible sources containing *generic* oil spill statistics has not been studied, since it was important in this study to have details about major accidents serving as a basis for further analyses.

B1.4 During the data search, Det Norske Veritas (DNV) had one staff in Moscow securing various forms of pipeline data for the survey from the following government ministries:

?? Ministry of Economy

?? Ministry of Fuel

?? Ministry of Transport

?? Ministry of Emergencies

B1.5 In the FSU, *feeder lines* are typically owned by *operator companies* (that is, the "Lukoils"), while *main crude lines* are owned and operated by the national Russian pipeline operator Transneft. Thus the most adequate source of crude oil pipeline data is Transneft. The company guards its pipeline information in such a manner that access is not possible without developing long-term, elaborate, and strategic relationships. However, the Ministry of Emergencies provided all of their data on spills between 1993 and 1996, which represents a wide and representative set of *major* spills (MChS 1998—see source no. 7 above). The information was in the Russian language, but was translated into English for this report. As a rule, the Ministry of Emergencies is notified on all major spills posing a hazard to human health and the environment. Therefore their database—which is part of our study (see reference above)—gives a good impression of *major* spills. The seven data sources listed above had entries for 212 accidents. However, several entries overlapped, and we had to combine all information from the sources in order to verify and confirm the authenticity of the 113 spills used in this study.

B1.6 About 40 percent of the recorded accidents (45) are recorded in two or more of the seven sources, while the remaining 60 percent (68, of which 50 are from MChS) are discussed in only one of the sources. Hence, for each of the 45 recorded accidents, the data given in Section B3 below was obtained by combining information from the various sources.

B1.7 Our data search showed that introducing additional sources does not necessarily add a large amount of new entries beyond those accidents we already know of.

Coverage

B1.8 The 113 accidents recorded in this study represent only a fraction of the total number of spills that really have occurred. Independent sources indicate that some pipelines have experienced several hundred smaller spills in one year due to their poor physical condition. Nevertheless, these 113 accidents should give a good picture of large oil spills for the years 1993–96. The variation over the years with respect to number of accidents is probably caused a variety of reporting levels and reporting regimes. Information on most oil spills exists, but is maintained by the separate pipeline owner/operators in a very disorganized form and in the local language. To obtain such information will certainly require efforts beyond the scope and schedule of this study.

B1.9 Hence, the accidents being recorded by the public sources are only those having had great impact on the environment or economy, or accidents for which the cleanup and recovery is monitored, performed, or financed by foreign countries or organizations. By combining the various sources, we have ensured that the information gathered for the 113 accidents is detailed and of high quality. Collecting more accidents would not necessarily have improved the data set for this study, although it may have been beneficial to have more detail about the 113 accidents.

B2. Oil Spill Statistics

B2.1 Summary statistics based on the reported accidents are given in the following tables (B1 – B4) below. Additional details of these accidents are give in Appendix B3.

Table B2.1. Number of Oil Spill Accidents by Location (State/Region) and Year of Occurrence, FSU 1986–96

	Year of occurrence								
Location	1986	1990	1991	1992	1993	1994	1995	1996	Total by location
Azerbaijan	—	—	1	2	—	—	—	—	3
Belarus	—	—	—	—	—	—	—	1	1
Kazakhstan	—	—	—	—	—	—	—	1	1
Latvia	1	—	—	—	—	—	1	—	2
Russia, East	—	1	—	—	11	10	16	6	44
Russia, Far East	—	—	1	—	—	—	1	—	2
Russia, North	—	—	—	2	—	1	5	3	11
Russia, South	—	—	1	1	3	1	1	8	15
Russia, West	—	—	—	—	—	2	1	2	5
Russia, Central	—	2	1	2	4	5	3	7	24

	Year of occurrence								
Location	1986	1990	1991	1992	1993	1994	1995	1996	Total by location
Ukraine	—	—	—	1	3	—	—	1	5
Total by year	1	3	4	8	21	19	28	29	113

Not available.
Source: Pipeline Oil Spill Prevention and Remediation in FSU, DNV, 1997

Table B2.2. Number of Oil Spill Accidents by Location (State/Region) and Cause of Spill, FSU 1986–96

	Cause of spill*						
Location	Mecha-nical failure	Corrosion	Operatio-nal error	third-party activity	Natural hazard	Unknown	Total by location
Azerbaijan	1	—	—	1	—	1	3
Belarus	—	—	—	—	—	1	1
Kazakhstan	—	—	—	—	—	1	1
Latvia	1	—	—	1	—	—	2
Russia, East	8	7	2	9	—	18	44
Russia, Far East	1	—	—	—	1	—	2
Russia, North	5	2	—	1	—	3	11
Russia, South	4	2	2	3	1	3	15
Russia, West	1	—	—	—	1	3	5
Russia, Central	7	2	3	2	—	10	24
Ukraine	3	—	—	—	1	1	5
Total by cause	31	13	7	17	4	41	113

Not available.
* The categories are according to CONCAWE definitions.
Source: Pipeline Oil Spill Prevention and Remediation in FSU, DNV, 1997

Table B2.3. Number of Oil Spill Accidents by Location (State/Region) and Diameter Class, FSU 1986–96

	Diameter class (inches)					
Location	8–14	15–22	24–32	> 32	Unknown	Total by location
Azerbaijan	—	—	—	—	3	3
Belarus	—	—	1	—	—	1
Kazakhstan	—	—	1	—	—	1
Latvia	—	—	2	—	—	2
Russia, East	—	17	15	11	1	44
Russia, Far East	—	1	—	—	1	2
Russia, North	—	1	10	—	—	11
Russia, South	2	4	6	1	2	15
Russia, West	—	3	1	1	—	5
Russia, Central	6	8	4	5	1	24
Ukraine	—	—	4	1	—	5
Total by class	8	34	44	19	8	113

Not available.

Source: Pipeline Oil Spill Prevention and Remediation in FSU, DNV, 1997

Table B2.4. Number of Oil Spill Accidents by Location (State/Region) and Spill Class, FSU 1986–96

	Spill class (metric tons)					
Location	0–100	100–1,000	1,000–10,000	> 10,000	Unknown	Total by location
Azerbaijan	2	—	—	—	1	3
Belarus	—	1	—	—	—	1
Kazakhstan	—	—	—	—	1	1
Latvia	1	1	—	—	—	2
Russia, East	10	4	7	3	20	44
Russia, Far East	—	1	1	—	—	2
Russia, North	4	3	1	1	2	11
Russia, South	4	4	1	—	6	15
Russia, West	—	1	1	—	3	5
Russia, Central	7	5	5	—	7	24
Ukraine	1	3	—	—	1	5
Total by class	29	23	16	4	41	113

Not available.
Source: Pipeline Oil Spill Prevention and Remediation in FSU, DNV, 1997

B3. summary matrix of the Relevant Characteristics of the Oil Spill Accidents.

B3.1 The matrix below summarizes the relevant characteristics of the 113 identified oil spill accidents. The reporting format is adopted from the one used by the Oil Spill Intelligence Report (OSIR). Each accident is given a unique identification number (used in the map in Appendix A. Relevant parameters considered include diameter of pipelines (in inches, if known); date of occurrence; approximate geographical location; amount of oil spilled in metric tons; and cause of spill (in line with CONCAWE classifications). These parameters were derived from a database containing the following information:

- ?? *Source of spill:* Name and diameter (in inches) of the pipeline. Pipeline length is also given when available. The owner of the pipeline is also given in some instances. Note that in some cases two or more pipeline diameters are given. This reflects the fact that the diameter is not given directly in the sources, and that we have done an evaluation of the possible diameter based on the available information about the accident (location of spill, name, and so forth) and the pipeline network information (see Appendix A). For risk assessment purposes the lowest diameter is applied.
- ?? *Spill scenario:* Date and cause of spill. Spill location is represented by region, distances from known or nearest cities, district and state, and so forth. Note that for the Russian spills, the “regions” defined in this study for Russia are also given.
- ?? *Product spilled:* The amount of crude oil spilled is given in gallons/metric tons.
- ?? *Spill impact:* The impact that the spill has had on the environment (rivers and lakes, land areas, drinking water, and so forth), on wildlife, the economy (for example, loss of production), and property (buildings, individuals, equipment, and so forth).
- ?? *Spill response:* Information on how the spill was dealt with; persons and equipment used (mobilization, recovery/clean-up works, and so on).
- ?? *Costs:* Accident costs related to the oil spill. Unfortunately, there is no consistent or uniform definition of “cost” given in the sources being used.

B3.2 As can be seen from the following descriptions, the amount and detail of information about accidents varies. Generally, it may be concluded that information on owner of pipeline and cost of accident is only sporadically recorded in the sources. In addition, spill impact on wildlife is not reported at all.

At the end of this section, all accidents are listed with a selection of relevant parameters.

Characteristics Matrix of Spill Occurrences

B3.3 All accidents are listed with a selection of relevant parameters in the following table

Table B3.1. Matrix of Characteristics of FSU Oil Spills

No.	*Pipeline Diameter (inches)*	*Date*	*Location*	*Spill Amount (metric tons)*	*Spill Cause*
1	28	11-May-86	Latvia	799	Mech. fail.
2	28	2-Apr-90	Russia Central	6,803	Mech. fail.
3	13	10-Apr-90	Russia Central	2,232	Unknown
4	21	14-Jul-90	Russia East	34	Corrosion
5	48	1-Apr-91	Russia Central	Unknown	Mech. fail.
6	Unknown	25-Apr-91	Russia Far East	500	Mech. fail.
7	Unknown	31-Jul-91	Russia South	500	Nat. Haz.
8	Unknown	30-Oct-91	Azerbaijan	32	Mech. fail.
9	Unknown	30-Jan-92	Azerbaijan	30	Unknown
10	40/48	15-Mar-92	Russia Central	5,392	Corrosion
11	28/32	9-Apr-92	Russia North	34	Unknown
12	Unknown	20-May-92	Azerbaijan	Unknown	3p activ.
13	28/32	1-Jun-92	Russia North	8,000	Mech. fail.
14	17/21/40	27-Jul-92	Russia Central	238	Unknown
15	28	3-Sep-92	Ukraine	34	Mech. fail.
16	13	20-Oct-92	Russia South	Unknown	3p activ.
17	48	12-Jan-93	Russia East	34	3p activ.
18	48	14-Jan-93	Russia East	34	Mech. fail.
19	28	15-Jan-93	Russia East	2,500	3p activ.
20	40	3-Mar-93	Russia East	Unknown	3p activ.
21	40	6-Mar-93	Russia East	20,000	Operat. error
22	28/40	7-Mar-93	Russia East	Unknown	Unknown
23	28	14-Mar-93	Russia East	Unknown	Unknown
24	28/40	14-Mar-93	Russia East	5,000	Mech. fail.
25	48	25-Mar-93	Russia Central	630	Unknown
26	48	27-Mar-93	Ukraine	Unknown	Unknown
27	28	9-Oct-93	Russia South	Unknown	Unknown
28	28	18-Oct-93	Ukraine	540	Mech. fail.
29	11/28	31-Oct-93	Russia South	Unknown	3p activ.
30	40/48	10-Nov-93	Russia Central	2,000	Mech. fail.
31	21	28-Nov-93	Russia East	3,000	Mech. fail.
32	11	4-Dec-93	Russia Central	Unknown	Unknown
33	28	12-Dec-93	Russia South	Unknown	Unknown
34	21	23-Dec-93	Russia East	3000	Mech. fail.
35	28	31-Dec-93	Ukraine	340	Mech. fail.
36	28	Unknown, 1993	Russia Central	Unknown	Unknown
37	20	1-Dec-93	Russia East	Unknown	Unknown
38	Unknown	29-Jan-94	Russia East	Unknown	Unknown
39	40/48	10-Feb-94	Russia West	2993	Nat. Haz.
40	21/28	11-Feb-94	Russia West	Unknown	Unknown
41	20	2-Mar-94	Russia Central	34	Mech. fail.
42	20	13-Mar-94	Russia East	Unknown	Unknown
43	28/40/48	31-Mar-94	Russia East	Unknown	Unknown

No.	Pipeline Diameter (inches)	Date	Location	Spill Amount (metric tons)	Spill Cause
44	28	11-May-94	Russia South	Unknown	Operat. error
45	21/28/48	11-May-94	Russia East	1,650	3p activ.
46	21	19-May-94	Russia Central	35	Operat. error
47	20	22-Jun-94	Russia Central	30	Operat. error
48	48	28-Aug-94	Russia Central	1000	Unknown
49	32/40	12-Oct-94	Russia Central	Unknown	3p activ.
50	28	25-Oct-94	Russia North	104,422	Mech. fail.
51	15	13-Nov-94	Russia East	Unknown	Unknown
52	21/28	26-Nov-94	Russia East	34	Mech. fail.
53	28/40/48	18-Dec-94	Russia East	35	Unknown
54	20	26-Dec-94	Russia East	Unknown	Unknown
55	48	26-Dec-94	Russia East	Unknown	Unknown
56	20	28-Dec-94	Russia East	35	Mech. fail.
57	28	7-Jan-95	Russia Central	44	Unknown
58	28	24-Jan-95	Russia North	300	Corrosion
59	28	23-Jan-95	Russia North	88	Unknown
60	20	10-Feb-95	Russia East	Unknown	Corrosion
61	40	17-Mar-95	Russia East	Unknown	Unknown
62	28/40	19-Mar-95	Russia East	1,000	Mech. fail.
63	40/48	29-Mar-95	Russia East	Unknown	Unknown
64	18	30-Mar-95	Russia West	Unknown	Mech. fail.
65	17	5-Apr-95	Russia East	6	3p activ.
66	28	12-Apr-95	Russia North	895	Mech. fail.
67	21	19-Apr-95	Russia East	1,000	Corrosion
68	28	19-Apr-95	Russia East	Unknown	Operat.error
69	21	24-Apr-95	Russia East	220	3p activ.
70	28/48	23-May-95	Russia East	Unknown	Unknown
71	21	29-May-95	Russia Far East	3,400	Nat. Haz.
72	28	12-Jun-95	Russia North	34	Mech. fail.
73	28/48	16-Jun-95	Russia East	20,000	3p activ.
74	Unknown	20-Jun-95	Russia Central	315	Operat. error
75	17	24-Jun-95	Russia East	Unknown	3p activ.
76	31+13	16-Jul-95	Russia East	34	Corrosion
77	32	9-Aug-95	Russia South	34	Mech. fail.
78	40	24-Sep-95	Russia East	Unknown	Unknown
79	48	4-Oct-95	Russia East	Unknown	Unknown
80	28	26-Oct-95	Latvia	50	3p activ.
81	28	13-Dec-95	Russia East	20	Unknown
82	21	21-Dec-95	Russia Central	50	Unknown
83	32	24-Dec-95	Russia North	408	Corrosion
84	28	27-Dec-95	Russia East	561	Corrosion
85	21	10-Jan-96	Russia South	156	Corrosion
86	48	11-Jan-96	Russia East	242	3p activ.
87	32	12-Jan-96	Russia North	77	3p activ.
88	20	16-Jan-96	Russia Central	100	Corrosion

				Spill	*Spill*
No.	*Pipeline Diameter (inches)*	*Date*	*Location*	*Amount (metric tons)*	*Cause*
89	20	19-Jan-96	Russia South	400	3p activ.
90	20	25-Jan-96	Russia South	Unknown	Mech. fail.
91	17	26-Feb-96	Russia East	Unknown	Unknown
92	17	26-Feb-96	Russia East	3	Corrosion
93	28	27-Feb-96	Russia North	54	Mech. fail.
94	48	7-Mar-96	Russia East	12,419	Mech. fail.
95	12	11-Mar-96	Russia Central	Unknown	Mech. fail.
96	20	20-Mar-96	Russia Central	510	Mech. fail.
97	13	22-Mar-96	Russia Central	Unknown	Unknown
98	28	10-Apr-96	Russia West	500	Unknown
99	12	17-Apr-96	Russia Central	Unknown	Unknown
100	28	5-May-96	Ukraine	500	Nat. Haz.
101	21	12-Jun-96	Russia East	Unknown	Corrosion
102	Unknown	17-Jun-96	Russia South	10	Corrosion
103	32	20-Jun-96	Russia South	123	Operat. error
104	28	21-Jun-96	Russia South	1,797	Mech. fail.
105	21	26-Aug-96	Russia North	Unknown	Unknown
106	25/32	28-Aug-96	Belarus	400	Unknown
107	28	1-Sep-96	Russia East	700	Unknown
108	20	5-Oct-96	Russia Central	88	3p activ.
109	21/28/40	18-Oct-96	Kazakhstan	Unknown	Unknown
110	10	22-Oct-96	Russia Central	4	Mech. fail.
111	40	14-Nov-96	Russia South	20	Mech. fail.
112	15	17-Nov-96	Russia South	0.14	Unknown
113	21/28	Unknown,1996	Russia West	Unknown	Unknown

Source: Source: Pipeline Oil Spill Prevention and Remediation in FSU, DNV, 1997

APPENDIX C: Canadian National Energy Board (NEB) Procedures for Protection of the Environment

C1. Environmental Assessment Process

C1.1 The Board's consideration of environmental matters predates both the Environmental Assessment and Review Process Guidelines Order (1984) and the CEA Act (1995). The Board has assumed a mandate for the protection of the environment under the NEB Act and the COGO Act. The NEB Act requires the Board to consider matters of public interest that could be affected by the approval of an application. The COGO Act requires the Board to ensure that oil and gas activities on Frontier lands are carried out safely, in a manner which protects the environment and involves sound reservoir conservation and operational practices. In addition, the Board is guided by the requirements of the CEA Act. The Board, as a responsible authority under the CEA Act, ensures that environmental assessments are conducted for projects under its jurisdiction according to the standards prescribed by that legislation. The CEA Act promotes the uniform consideration of environmental matters across federal departments and agencies, and is intended to encourage a one project, one assessment approach.

C1.2 The purposes of the CEA Act are:

- ?? to ensure that the environmental effects of projects receive careful consideration;
- ?? to promote sustainable development and thereby achieve or maintain a healthy environment and economy;
- ?? to ensure that projects do not cause significant adverse environmental effects; and
- ?? to ensure an opportunity for public participation in the environmental assessment process.

C1.3 Under the CEA Act, an environmental effect is defined as:

- ?? any change that the project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site, or thing that is of historical, archaeological, paleontological, or architectural significance; and
- ?? any change to the project that may be caused by the environment; and

- ?? whether any such change occurs within or outside Canada.

C1.4 The CEA Act also requires that cumulative environmental effects be onsidered in an environmental assessment.

There are four sets of regulations that guide the application of the CEA Act. They are:

- ?? Law List Regulations - these regulations list the provisions of various Acts which trigger environmental assessment under the CEA Act. The section of the NEB Act that relates to the construction and operation of a pipeline is one such example.
- ?? Inclusion List Regulations - these regulations define which physical activities require environmental assessment under the CEA Act. Examples of NEB regulated physical activities would be the carrying out of drilling programs on Frontier lands or the abandonment of the operation of a pipeline.
- ?? Exclusion List Regulations - these regulations determine the types of projects which do not require an environmental assessment under the CEA Act. However, when appropriate, projects excluded under the CEA Act, such as certain pipeline maintenance or repair projects and energy exports are assessed by the Board according to the NEB Act.
- ?? Comprehensive Study List Regulations - these regulations establish projects which require a comprehensive environmental study. Certain applications before the NEB meet these criteria. An example would be the construction of a new pipeline over 75 kilometres in length on a new right-of-way.

C1.5 If a project fits the criteria for a comprehensive study, the Board may either conduct the study and then submit the report to the Minister of the Environment, or the Board may refer the project to the Minister for a panel review. The Minister may also decide, based on the findings of the report, to initiate a panel review. In the event of a panel review, the Minister may choose to substitute an environmental assessment by a separate review panel for the Board's hearing process or choose to establish a joint panel. For panel reviews, the Canadian Environmental Assessment Agency makes intervenor funding available for those individuals or groups that meet certain criteria and wish to participate in the hearing process.

C1.6 One of the benefits of the CEA Act is the ease with which the public can access information about specific environmental assessments. As part of the public notification procedure, a public registry system has been established through the CEA Agency to identify projects which are to undergo an environmental assessment according to the CEA Act. For more information on the registry system contact:

Public Registry Coordinator
Canadian Environmental Assessment Agency
200 Sacré-Coeur Blvd., 13th Floor

Hull, Quebec
K1A 0H3
Phone: (819) 997-1000
Fax: (819) 994-1469

C2. Environmental Assessment Information Requirements

C2.1 The Board's Guidelines for Filing Requirements, dated 22 February 1995, specify information that must be filed by an applicant when seeking authorization to construct, operate, maintain, or abandon a pipeline. Environmental information requirements for the construction of power lines under the Board's jurisdiction can be found in the Memorandum of Guidance to Interested Parties Concerning Full Implementation of the September 1988 Canadian Electricity Policy revised 2 April 1997. The Board's environmental information requirements for international power lines are contained in the Electricity Regulations.

C2.2 Applicants are required to file information detailing how the proposed project(s) would affect the environment and what proposed mitigative measures the company would implement. The level of detail the Board requires may vary with the magnitude of the project and its potential for environmental effects. This environmental information will be one of the determining factors in the Board's decision making process. The same information will be used by the Board to monitor the construction, operation, and maintenance of facilities and to ensure compliance with the commitments made by the applicant. All project-related information, including environmental reports submitted by the applicant, are available for public viewing in the Board's library.

Pipeline Activities

C2.3 Environmental information submitted by a project applicant must include a detailed description of the project, site or routing information, a description of the effects of the project on the environment, proposed mitigative measures, contingency plans for dealing with environmental emergencies, and descriptions of any inspection and monitoring programs. Oil and gas pipeline projects are assessed according to the NEB Act, the COGO Act and the CEA Act.

C2.4 Environmental considerations relating to pipeline construction and operation may include:

?? conflicts with existing land-uses; soil conservation on agricultural lands;

?? preservation of wildlife and fish habitat;

?? avoidance of sensitive areas and seasons for fish and wildlife species;

?? protection of rare or unique plant communities, rare and endangered wildlife, and associated habitat;

?? contamination of soil and groundwater;

?? conservation of timber resources;

?? preservation of heritage resources;

?? preservation of water resources; and

?? effects from above-ground facilities, such as noise and air emissions, and aesthetics.

C2.5 Environmental issues vary depending on the scope, location, timing, and nature of the project. Factors such as soil erosion, soil mixing and compaction along a pipeline trench or right-of-way from vehicle traffic can be a greater or lesser concern depending on the location. For example, these effects may have the potential to disrupt the natural drainage of farmland and impair its agricultural capacity.

C2.6 The Board may request that the applicant develop an environmental issues list (EIL) as a management tool. This assists in tracking the resolution of environmental concerns described in the application and is used during the assessment, construction, and post-construction phases of the project. In the EIL, environmental issues and their means of resolution are identified for each specific location. The NEB reviews the EIL and monitors the actions taken toward the resolution of issues.

Frontier Projects

C2.7 Frontier oil and gas projects vary in both type and location. They range from onshore seismic data acquisition to Arctic offshore production. Depending on the situation, potential concerns can relate to factors such as timber cutting, dredging, artificial island construction, aircraft and vessel traffic, waste handling, and well blowouts. Environmental assessment of Frontier projects are carried out under both the COGO Act and the CEA Act.

Environmental considerations relating to Frontier projects may include:

?? effects of offshore oil spills;

?? effects of underwater noise from drilling and marine transportation on fish and marine mammals;

?? protection of polar bears and marine mammals;

?? wildlife and fish habitat and population protection;

?? effects of waste discharges from offshore rigs;

?? hazards to operations posed by sea ice, icebergs, and severe storms;

?? protection of permafrost;

?? contamination of soil and groundwater;

?? water pollution;

?? public consultation; and

?? socio-economic effects arising directly from environmental effects.

Exports

C2.8 Since energy exports are not included in the Law List Regulations, they are not subject to environmental assessment according to the CEA Act. A consideration of environmental matters in relation to energy exports is done under the authority of the NEB Act. For long-term gas export authorizations (over two years), the Board has relied upon the necessary connection test. Applicants may be requested to file information sufficient to determine if the requirements of the applied-for export licence and new facilities or activities are integrated to the extent that they can be seen to form part of a single course of action. If new facilities or activities will be constructed or undertaken, as per the necessary connection test, applicants could be requested to file an assessment of the potential environmental and directly-related social effects of those new facilities or activities. Environmental considerations related to upstream facilities could also arise for applications to export energy other than natural gas.

C3. Additional Considerations and Information Requirements

Socio-economic Matters

C3.1 In addition to physical and biological effects, energy activities also have the potential to affect social, economic, and cultural environments. Traditionally, the Board has considered these effects as a matter of public interest and also as a component of the environment under both the NEB Act and the COGO Act.

Socio-economic considerations can vary, and may include:

?? local and regional economic impacts and effects;

?? demographic effects such as changes in population numbers and distribution;

project-related public fiscal expenditures;

?? health effects such as those related to noise and gas emissions, water degradation, and other pollutants;

?? cumulative effects on the basic economy or traditional culture of the affected area or surrounding region; and

?? other patterns of human disturbance.

C3.2 Under the CEA Act, the Board has a responsibility to assess certain effects that flow directly from environmental changes, including effects on:

?? human health;
?? socio-economic conditions;
?? physical and cultural heritage, including effects on items or sites of archaeological, paleontological, architectural significance; and
?? the current use of lands and resources for traditional purposes by aboriginal persons.

C3.3 Information submitted by an applicant is required to include confirmation showing that the applicant is fully aware of any significant socio-economic effects of the proposed project, has measures in place to mitigate adverse impacts and to promote positive outcomes, and is committed to carrying out those measures. These requirements help to ensure that the project benefits not only the producers and consumers but also, to the extent possible, those people directly affected in the local area.

Right-of-Way Matters

C3.4 It is possible to minimize the adverse environmental effects of pipeline construction through careful route selection. Companies are encouraged when selecting a route to avoid sensitive areas for wildlife, plants, fish and human activities, wherever possible. By developing comprehensive route selection studies and processes, impacts on environmentally sensitive areas can usually be reduced or avoided. The Board's Guidelines require applicants to provide information on pipeline routing, including alternative routes if considered, the route preferred by the company, and the rationale for the preferred route. Land requirements for pipelines and facilities are also assessed by the Board to ensure the amount of land required is reasonable and justified.

Public Notification

C3.5 The Board's Guidelines establish how an applicant is expected to notify the public of energy projects under its jurisdiction. In most instances, the applicant is required to:

- ?? implement a public information program;
- ?? explain the proposal under review to the interested public;
- ?? allow an opportunity for public comment;
- ?? provide information to the public about possible environmental and social effects; and
- ?? respond to enquiries concerning the project.

C3.6 When filing an application with the Board, the applicant must provide information regarding the public notification program, meetings with interested parties, and a summary of public comments and concerns. For certain types of projects, such as those for which no significant environmental or social concerns have been identified, an applicant has the right to seek an exemption from the Board's public notification requirements.

C.4 Post Approval Activities

Inspection and Monitoring

C4.1 The NEB requires that companies employ qualified inspectors to oversee construction activities. The Board also conducts its own inspections and audits to ensure that construction activities comply with applicable legislation and the conditions of project approval.

C4.2 Once construction has been completed, the company is required to restore and maintain the right-of-way in a condition acceptable to both the landowner and the Board. The right-of-way is normally restored so that it is similar to the surrounding environment and consistent with current land use. Typically, restoration is completed within one or two years following construction.

C4.3 On most pipeline projects, the Board requires that the company file post-construction reports identifying any environmental issues that have arisen during the reporting period. These reports must indicate those issues which have been resolved, those which remain unresolved, and the measures the company proposes to take regarding unresolved issues. Typically these reports are filed six months after the completion of construction, and then again after each growing season for the next two years.

C4.4 Inspections and audits by the Board continue into the operating phase of projects. Rights-of-way for all projects under NEB jurisdiction are checked periodically to confirm the effectiveness of ongoing environmental protection measures. Specific operational issues, such as noise emissions from compression and pumping facilities, are also periodically monitored.

C4.5 Companies are also required to maintain and update operation and maintenance manuals and routinely check for signs of pipeline leaks or impacts to the land along the right-of-way, such as slope movement, erosion, compaction, weed infestations, and infringements on the right-of-way by third parties. When ongoing issues are identified, the Board can require that further action be taken by the company to remediate the situation.

C4.6 Environmental inspections of Frontier activities involve verifying a company's compliance with, and the effectiveness of, environmental operating requirements. For example, requirements and standards have been put in place for the measurement, observation and prediction of weather, sea ice, and sea conditions to ensure the safety of operations and the environment in an offshore setting. In addition, operators of offshore production projects are required to submit environmental protection and monitoring plans. To verify environmental assessment predictions and to determine the effectiveness of mitigative measures, the Board reviews these reports and monitors compliance with the plans.

Contingency Plans for Environmental Emergencies

C4.7. Since the potential exists for accidental releases from pipelines and facilities, the Board requires companies to establish procedures for handling these incidents. These procedures must be detailed in a contingency plan which is filed with the Board. Where there is a potential for incidents to significantly affect the environment, public health, or safety, the Board requires companies to establish an emergency response plan.

C4.8 When an incident occurs, the company must report it to the Board immediately. For significant incidents, Board staff monitor the company's response to ensure that appropriate recovery, clean-up, and site restoration activities are carried out. After repairs are made and the site is restored, the company must file a report with the NEB describing the location, extent of damage, volumes of product lost, containment measures, and the clean-up and restoration procedures. In the case of a serious incident, the Board may call a public inquiry to evaluate emergency, safety, and environmental protection procedures and associated regulations.

C4.9 To address any potential consequences of Frontier exploration activities, especially in offshore areas, companies are required to test their contingency and emergency response plans. This is accomplished through simulated emergency response or spill exercises. These exercises are designed to test response strategies and communications systems, and to provide an opportunity for field staff to gain practical experience in the deployment of spill response equipment.

Financial Liability and Security

C4.10 The COGO Act allows claims for compensation of actual loss or damages resulting from the release of oil, gas or debris resulting from regulated activities. Prior to the issuance of an authorization under the COGO Act, the Board requires proof of financial responsibility to be demonstrated by the applicant. The Board may, if necessary, act directly to resolve outstanding issues by using the financial securities held by the Board.

Landowner Concerns

C4.11 Environmental problems are likely to be noticed first by landowners or property tenants. However, anyone who believes a company's construction procedures or facility operations are causing adverse environmental effects should contact both the company and the Board. In response, the company is required to contact the affected landowner and reply to the Board outlining actions taken to resolve the situation. The Board's responsibility is to ensure that appropriate actions have been taken by the company to address concerns.

Abandonment

C4.12 Abandonment of any pipeline or related facility regulated by the NEB requires prior Board approval. The NEB assesses whether the abandonment will have any adverse environmental effects and what restoration work will be required. A restoration plan is approved before work begins to ensure that land disturbed by the removal or sealing of a pipeline, or the decommissioning of surface facilities, is restored.

C5. Keeping Current

C5.1 The field of environmental protection is constantly undergoing new developments. The NEB updates its policies and procedures as necessary to ensure that facilities within its jurisdiction receive the benefit of up-to-date environmental regulation and to take into account the development of improved construction and mitigation measures.

APPENDIX D: Pipeine Regulations and Standards of the Russian Federation

D1.1 The following instructions and regulations are expected to be used to regulate various safety aspects of oil and gas activities in the Russian Federation. The source is DNV, 1998, based on VNIIGAS materials plus some latest input from Transneft.

1. "Instructions on the Technical Investigation and Recording of the Emergencies which did not Entail Casualties at the Companies and Sites under the Sphere of Competence of the Gosgortekhnadzor of the USSR." Approved on July 11, 1985, with changes and amendments made in 1987.
2. "Methodological Instructions for Establishing the Remaining Life of Potentially Hazardous Sites under the Sphere of Competence of the Gosgortekhnadzor of Russia" (RD 09-102-95). Approved on November 17, 1995.
3. "Rules for the Certification of the Products Subject to Supervision for Potentially Hazardous Industrial Facilities, Sites and Activities" (RD 03-85-95). Approved on February 2, 1995.
4. "Recommendations for Arranging and Carrying Out the Supervision of the Readiness of Mining Rescue, Fountain Control, Gas Rescue, Emergency Control Services and Recovery Trains of the Railway Ministry of Russia to Localize the Possible Emergencies" (RD 03-32-93). Approved on September 22, 1993.
5. "Provisional Procedure for Notifying and Submitting Information to the Authorities of the Gosgortekhnadzor of Russia Regarding Emergencies and Hazardous Operating Conditions at Gas and Hazardous Liquids Main Pipeline Transport Facilities" (RD 08-90-95). Approved on May 4, 1995.
6. "Instructions for Arranging and the Safe Execution of Work when Eliminating Gas and Oil Fountains." Approved by the Gosgortekhnadzor of the USSR, the Ministry of Oil Industry of the USSR, the Ministry of Gas Industry of the USSR and the Ministry of Geology of the USSR in 1971.
7. "Methodological Instructions for the Risk Analysis of Hazardous Industrial Facilities" (RD 08-120-96). Approved on July 12, 1996.
8. "Regulations for the Procedure of the Development (Designing), Admission for Testing and Commercial Production of New Drilling, Oil and Gas Field, Geological Exploration Equipment, Equipment for Pipeline Transport and Designing the Processes Included into

the List of Facilities Subject to the Monitoring of the Gosgortekhnadzor of Russia" (RD 08-59-94). Approved on March 21.

9. "Oil and Gas Industry Safety Regulations." Approved on December 14, 1992 with changes and amendments made on June 6, 1996.

10. "Main Pipeline Security Measures." Approved on April 24, 1992. with amendments made in 1994.

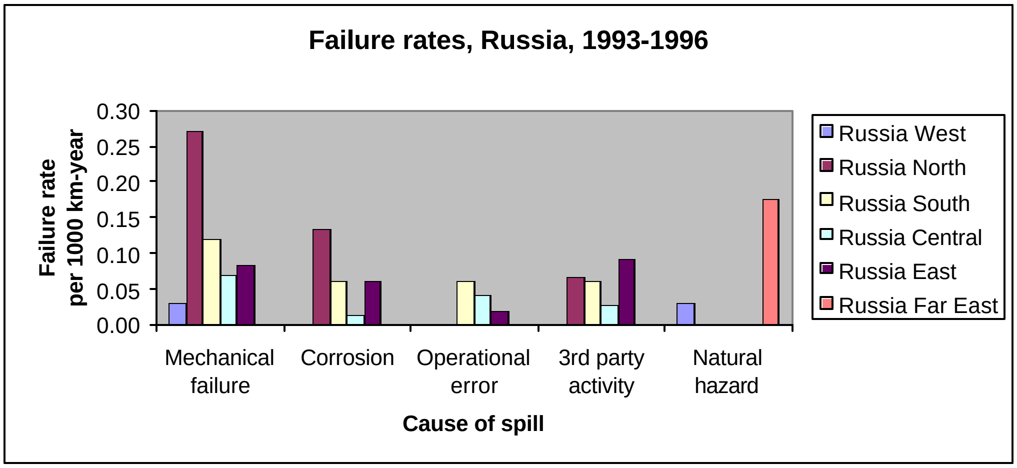
D1.2 The following federal standards and norms apply to pipelines:

- ?? SNiP 2.05.06-85. "Construction Norms and Regulations. Main Pipelines."
- ?? SNiP III-42-80. "Construction Norms and Regulations. Rules for the Execution and Acceptance of Work. Main Pipelines."
- ?? GOST 25812-83. "Main Pipelines of Steel. General Corrosion Proofing Requirements."

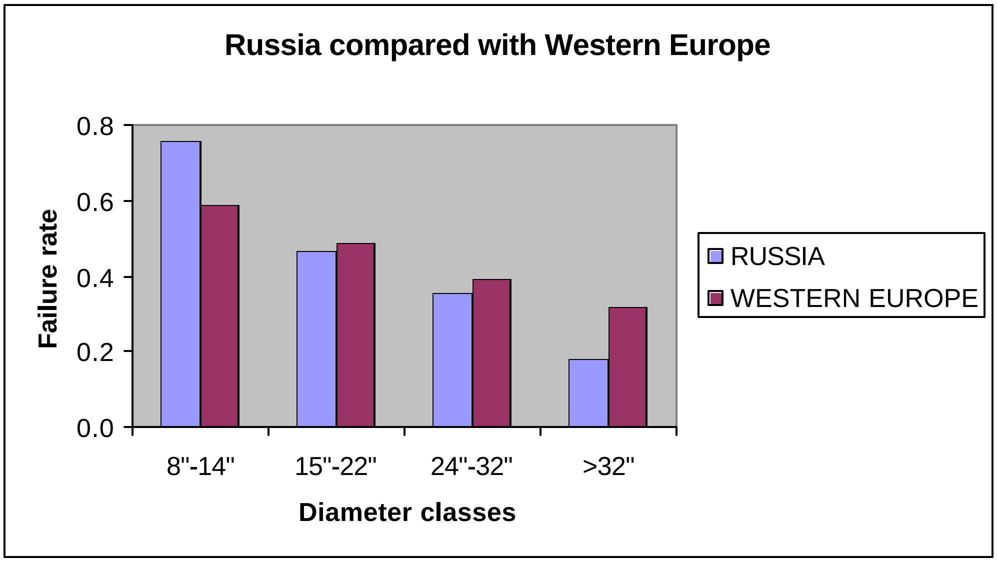
D1.3 The industry standards that apply to pipelines are as follows:

- ?? VNTP 2-86. "Main Pipeline Technological Design Norms."
- ?? VNTP 3-85. "Technological Design Norms for Oil, Gas and Water Gathering, Transport and Treatment Facilities at Oil Fields."
- ?? VSN 51-3-8. VSN 2-38-85. "Design Norms for Field Pipelines of Steel."

Appendix E: Comparison of Pipeline Failure Rates in Russia and Western Europe



Source: Pipeline Oil Spill Prevention and Remediation in FSU, DNV, 1997



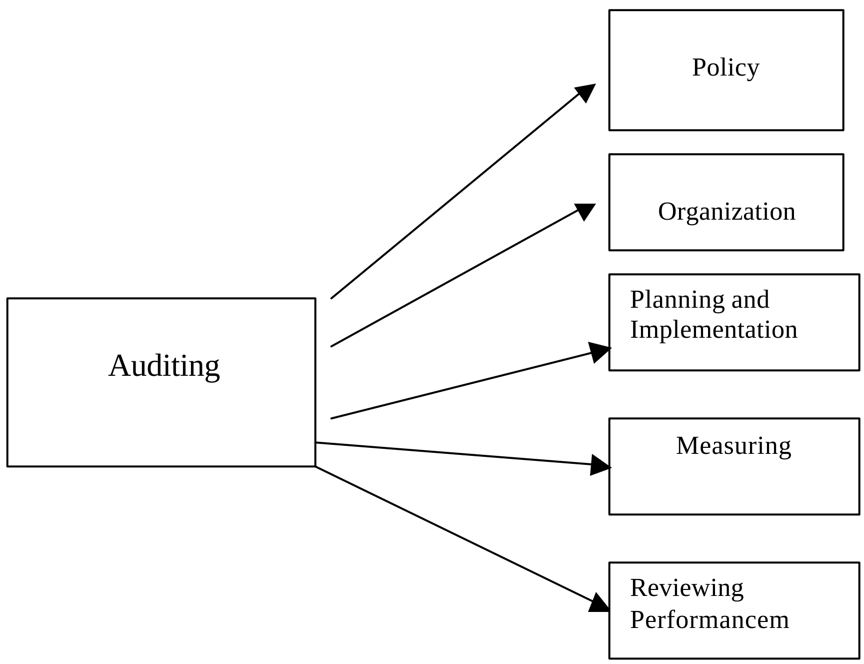
Source: Pipeline Oil Spill Prevention and Remediation in FSU, DNV, 1997

Appendix F: Methods of Prevention and Detection and Control of Spillage in European Oil Pipelines

F1. Pipeline integrity management systems

F1.1 The oil industry regards pipelines as one component of its overall business and assets. It therefore applies a similar safety management system as in all other activities. The Western oil companies have in general developed systems similar to that shown in the figure below whereby there is feedback at all stages to ensure continuous improvement.

Figure F1.1. Outline of a Safety Management System



Source: Pipeline Oil Spill Prevention and Remediation in FSU, DNV, 1997

F1.2 Such systems have been developed to improve the safety performance of companies partly from community and legislative pressure, partly from their desire to protect their workforce and neighbors, but not least for business reasons. Accidents are costly and can result in fines, lack of customer confidence, difficulties in retaining the license to operate, and in particular financial losses from an interruption to business. A particular safety management system has evolved for pipelines and is referred to as a Pipeline Integrity Management System or PIMS. In this section, the general principles are described. The detailed procedures used to prevent and detect spillages are presented in sections F4 and F5.

Technical integrity

F1.3 Initially, integrity was supposed to refer to the elimination of danger, but over the years this has been extended to include a "fit for purpose" condition to allow the facility to fulfill its intended function. Consequently a current definition of integrity would refer to the Technical Integrity of a facility, which is achieved when, under specified operating conditions, there is no unacceptable risk of failure endangering safety of personnel, environment, asset value, or facility availability. Risk of failure is defined as the product of failure probability and failure consequence.

F1.4 First, Technical Integrity needs to be created. This is achieved during the project phase. The core requirements are competent design (based upon a well-understood and formally approved operational philosophy) and assurance of the quality of the materials, equipment, and construction activities. This needs to be carried out in line with an agreed set of standards.

F1.5 Second, Technical Integrity needs to be safeguarded. Keys to this are effective and controlled procedures to ensure adequate maintenance and safe operating practices. These procedures must include a thorough maintenance planning process to ensure that necessary actions are identified and implemented in a timely manner, work execution procedures to minimize induced hazards, contingency planning to contain any potentially hazardous occurrence, and staff training to ensure an appropriate skill profile.

F1.6 Technical Integrity is equated to the degree of confidence in the facility withstanding all design flaws or accidental events. Clearly, this does not equate to total confidence, since the remote possibility of the thousand year storm, or the meteorite collision still exists,, and defense against these occurrences is not provided by design.

F1.7 Any deficiencies in the project phase will result in a shortfall in the desired level of integrity. However, in view of the many controls in place at the time of project handover, the shortfall is usually small at this point. After this, adequate management control is essential, otherwise there will be a drift away from the desired state of resilience to accidental events considered in the design phase.

Management controls

F1.8 Operator errors are normally not the main cause of the adverse trends, as in most cases operator errors will be quickly noted and eliminated. Rather adverse trends are a result of the evolutionary divergence of actual practice from authorized procedures, introduction of inadequately trained personnel and, under day to day pressure, the piecemeal and unrecognized neglect of appropriate operating practices (including excursions outside design operating conditions) and mandatory maintenance.

F1.9 Management controls, including procedures necessary to ensure an effective information flow, are essential to counterbalance threats to Technical Integrity. Such controls should include change control and procedures for monitoring deviation. Technical reviews and audits may result in listings of remedial actions, the implementation of which will ideally restore Technical Integrity. Where effective formal systems are in place the shortfall should be minimal.

F1.10 Western operators have recognized the need for a more proactive approach to identifying areas of potential exposure and have developed Pipeline Integrity Management Systems (PIMS). A comprehensive set of controls, encompassing all integrity management aspects, should be in place. The key elements for such a PIMS can be listed as follows:

- ?? clear objectives and policies, inclusive of acceptable risk levels and an indication of priorities;
- ?? a suitable organization with clear definitions of asset ownership and related responsibilities and competent and adequately trained staff;
- ?? adequate standards and procedures, inclusive of deviation control; and
- ?? performance monitoring and suitable audit/review procedures.

F1.11 Objectives and Policies of course have to be compatible with other corporate objectives. Nevertheless, identification of unacceptable risks, desired system availability, and clear statements reconciling production priorities with maintenance requirements are a must to avoid having to rely on ad-hoc decision making in the field, with all the related consequences for the Technical Integrity of the system. These policies and objectives are particularly important for pipelines.

F1.12 For each pipeline or group of pipelines the asset holder is identified and delegated PIMS responsibilities for each life-cycle phase defined. Particular attention is paid to the interfaces between the various life-cycle phases, where different organizational parties carry responsibilities with regard to pipeline integrity.

F1.13 PIMS cannot be successfully implemented without the full cooperation of all staff involved. It is therefore important that the staff responsible for executing critical activities related to pipeline integrity are fully involved in setting up a PIMS and are motivated to follow system requirements. Staff numbers, skills, and experience to comply with all the requirements specified in the PIMS need to be adequate. Training that covers the various technical aspects related to the creation and safeguarding of pipeline integrity must be provided by the owner/operator.

F1.14 Relevant expertise areas for the critical activities in a PIMS are pipeline engineering; process technology; materials and corrosion engineering; operation and maintenance; telecommunication; instrumentation; and so forth. Materials and corrosion specialists play a particularly important role in the design, construction, and operations phases of pipeline integrity.

Risk assessment

F1.15 Risk can be minimized by either reducing the probability of failure or by reducing the consequences of failure. The probability of failure by external impact can be reduced by greater pipeline wall thickness or by applying concrete coatings, routing pipes away from high risk areas, increasing the depth of burial, and regular line surveillance. The probability of mechanical failure can be reduced by adequate materials, rigorous construction specifications, and inspection during line pipe manufacturing and construction (for example, 100 percent radiographic testing of welds). The probability of failure by corrosion can be reduced by greater wall thickness, improved coating, Cathodic Protection systems, product treatment and inhibition, and regular inspections. The consequences of failure can be reduced by strategic pipeline routing, installing isolation valves with automatic or remote operation, and implementing leak detection and emergency response systems.

F1.16 The integrity of the pipeline during its lifetime needs to be maintained by means of condition monitoring, fitness for purpose analysis, and implementation of remedial actions and improvements where necessary. The condition-monitoring program should be based on anticipated degradation mechanics. Condition monitoring can involve line surveillance, coating and cathodic protection surveys, fluid corrosivity assessment with probes, coupons and fluid assessment, and intelligence pig inspection.

F2 Prevention of Spillages in the Design Phase

F2 .1 Detailed studies of the pipeline route, design, and location of associated equipment are carried out to eliminate causes of failure and to minimize the effects of pollution in the case of spillage. Pipeline design is regulated by strict national and international standards and specifications, which are subject to continuous review and updating.

F2.2 It is important that the initial design studies are thorough and that all foreseeable problems are reduced to an acceptable level during the design process. Studies are undertaken at this stage of the impact of the pipeline on the environment and the potential hazards that may be introduced. The pipeline route and the locations of the pumping and valve stations are defined for the fluid to be transported and the topographical features where the equipment is to be installed. The final design will aim to provide the best balance between plant, owners' requirements, and the environment.

Pipeline route

F2.3 The choice of pipeline route is an important factor in ensuring the safety of the public, protection of the environment, and integrity of the pipeline itself.

F2.4 The design criteria for obtaining the most acceptable route are as follows:

?? Select the optimum route feasible taking into account existing environmental, technical, and economic constraints.

?? Avoid or minimize the crossing lengths of areas of special geological or geographical conditions that may create hazards.

?? Avoid or minimize the crossing lengths of areas where failure may result in substantial ecological damage.

F2.5 Soil studies, topographical surveys, and geological information are assessed to obtain technical solutions for crossing all obstacles (such as difficult terrain, roads, rivers, and railways). Special attention is given to the design of crossing important rivers and stretches of water. Underground routes are usually preferred to above ground routes where possible.

F2.6 Hazard assessments and environmental studies that assess the effects of, for example, noise, pollution, and accidents on the local population, are reviewed in more detail as the system design develops. Inevitably some degree of compromise between these various criteria may be required. However, the overall aim is to reduce risks to acceptable levels, using additional technical measures where necessary.

Mechanical design

F2.3 The mechanical integrity of the pipeline is assessed by evaluating the stresses, pressures, and external loads that could be experienced by the pipeline. Different operating modes are considered by varying the conditions such as flow and pressure. The design is checked against what could occur under all possible operational conditions, such as:

?? hydraulic pressure gradients under steady flow conditions at the different flow rates;

?? static pressure under no flow conditions; and

?? pressures developed under transient flow conditions, with particular account being taken of surge effects.

F2.4 From these operating modes it is possible to define the best location for the pump stations, their power requirements, the subdivision of the pipeline into several sections, and the positioning of the valves. The operating pressure can be defined as the pressure required to maintain a given flow rate through the pipeline taking into account the pipeline profile and the residual pressure at the end of the pipeline. The design pressure must be equal to or higher than the maximum operating pressure under any flow condition, including static pressure under no flow conditions (pumps running against closed valves).

F2.5 The minimum wall thickness is calculated (including a safety factor) from pressure data, type of steel pipe, and other factors including the handling pipes without damaging them, resistance to stresses imposed during pipeline construction, and resistance to deformation under external loads.

F2.6 Thermal, hydraulic, mechanical, and fatigue stresses are also considered, in order to ensure that the maximum allowable stress values are not exceeded for the selected pipeline wall thickness. Provision is made where necessary for suitable devices to automatically limit the maximum pressure excursions due to surge caused by transient flow conditions.

F2.7 In recent years the use of intelligence pigs (see Section F4.3) for inspecting the condition of pipelines has increased. The use of pigs, particularly intelligence pigs, involves special considerations for mechanical design. Launching traps and receiving traps must be suitable for their operation and all bends must have adequate radii. Section F4.5 reviews internal inspection. All pipes and ancillary equipment incorporated into a pipeline are rated to withstand design pressures and loads, at least those used for the pipeline.

Mechanical protection

F2.8 Isolation valves are installed along the pipeline route so that the pipeline can be quickly divided into sections in the event of an emergency. This minimizes the available contents that could spill. Various Codes of Practice make recommendations on the spacing of valves, particularly in areas of dense population. In certain circumstances non-return valves are installed in the place of isolation valves. These valves only permit flow in one direction and prevent the contents of the pipeline draining back to a rupture point in an emergency, thereby reducing any spillage. Overpressure protection devices, such as pressure relief valves, may be installed at appropriate locations to limit the maximum pressure of the pipeline under transient or incorrect operating conditions. A compromise is required on the number of valves and fittings in the main line; the more that are introduced, the greater the possibility for valve seal or flange leakage.

External corrosion

F2.9 Corrosion is electrochemical in form. When an unprotected pipe is buried in moist soil conditions, an electric current flows from the metal (the anode) to the soil (acting as cathode). The metal from which the current flows will dissolve in the surrounding moisture. This is apparently the main cause of pipeline corrosion. There are two ways of preventing this corrosion: isolating the pipeline from the soil with an electrically insulating protective coating; or cathodic protection, which reverses the flow of current (that is, from the soil to the metal). Though it is possible to use cathodic protection and coatings independently, they are commonly used together. If for example the coating has a fault, then the cathodic protection will shield the line. Coatings are applied either during manufacture of the steel pipe or during construction of the pipeline. In the former case, additional protection is applied to the joints during manufacture. The manufacturing methods, material properties, application techniques, and testing procedures for protective coatings are governed by national and international standards. However, these coatings can be damaged during construction or operation or may deteriorate with time, and it is therefore normal to both coat the pipeline and to provide a cathodic protection system. Cathodic protection is an efficient and well-proven technique and is specifically tailored for each individual application. Special consideration must be given to sections of the pipeline where other forms of electrical interference such as power cables or overhead transmission power lines are present. Sometimes it is necessary to install insulation joints at intermediate locations along the pipeline thereby dividing it into electrically independent sections.

Internal corrosion

F2.10 Internal corrosion has not proved to be a major cause of failure to pipelines transporting crude oils or most oil products. However, in the few circumstances where corrosive products are to be transported there are methods to limit corrosion such as inhibitors and internal coatings. Pigs are frequently used to displace any corrosive products including water that may settle and collect at the low points of the pipeline. The ability to monitor corrosion conditions is discussed in sections F 2.9 and F 2.10. Inhibitors work by forming a protective film on the internal surface of the pipeline, thereby reducing corrosive interaction with the product. The inhibitor has to be specifically selected to avoid contaminating the product being transported and would normally be continuously injected. Internal coatings are of benefit in certain circumstances. Their application and long-term integrity need thorough assessment.

Natural hazard and third party protection

F2.11 In areas where significant natural hazards occur and it is not possible to re-route the pipeline, special precautions are taken in the design. These can involve increasing the strength of the pipeline, stabilizing the surrounding ground, and installing instrumentation to record earth movements such as subsidence which are likely to produce excessive stresses in the pipeline. Landslides and subsidence, occurring in mining areas for example, exert stresses on pipelines. These phenomena and stresses can be detected and monitored by topographical surveys, strain gauges, or monitoring instruments installed at locations of high risk along the pipeline. Where ground movements are detected, rectification measures can be implemented where necessary. In areas where there is a high risk of third party damage, such as near highway boundaries, pipelines can be safeguarded by additional protective measures. To ensure that the integrity of the pipeline is maintained, it is common practice to regularly patrol the pipeline wayleave (see Section F 4.4). Pipeline facilities such as pump stations and tank farms are generally protected by enclosing them in security compounds with access only permitted to authorized personnel.

F3 Prevention of spillages: construction and commissioning phases Construction

F3.1 Safety is a major factor during the design of a pipeline and continues to be an important consideration during the construction and commissioning phases. Construction requires the successful coordination of technical, financial, and human resources in order to complete the pipeline to the specified quality, on program, and at the required cost. Detailed engineering studies for the construction of the pipeline are completed. Technical specifications are prepared which are used as the basis for tenders for the purchase, inspection, and installation of equipment. Each equipment and construction order contains a technical specification that typically includes a detailed description of the needs of the client, from standards to on-site testing. Emphasis is placed on quality assurance and control. Firms are selected to receive orders for equipment or contracts for services after a stringent prequalification procedure. The inspection of the equipment and the works is either performed directly by the client or by a specialized inspection organization appointed by the client. Inspection takes place at all critical steps of construction, from suppliers’ factories to final inspection of works on site. In this way the owner/operator can ensure that equipment and installations comply with the order requirements. When construction is complete, precommissioning operations are carried out. This work includes pipe cleaning, leak and pressure testing, and gauging for pipe deformation. It may be useful to carry out an initial on-site inspection (see Section F 4.3) to establish a baseline of the condition of the pipeline. An important safeguard introduced at the end of construction is the hydrostatic pressure test of the installed pipeline. Water is used to pressurize the pipeline well beyond the normal operating pressure. The pressure is usually held at this level for 24 hours. This test establishes the strength of the pipeline and its components and verifies the absence of leaks.

Commissioning

F3.2 Upon completion of the precommissioning the pipeline is handed over for commissioning. During commissioning, the owner/operator carries out operational tests and makes any necessary adjustments prior to operating the pipeline. Complete documentation is kept at every stage of the pipeline construction and upon completion a reference book is typically prepared for the pipeline.

F4 Prevention of Spillages during Operation Phase

F4.1 An operating pipeline requires control, maintenance, and surveillance. The control center monitors functioning variables through the instrumentation on the pipeline in order to ensure safe and efficient operation. Maintenance is conducted on a planned formal basis. Surveillance is carried out regularly to check the general condition of the pipeline route, to ensure that no unauthorized work is being started near the pipeline, and to check that the pipeline is not endangered in any other way. Such surveillance can be carried out either from the air or on the ground or both.

Control Room

F4.2 The control room is the nerve center of a pipeline. The essential instrumentation on the pipeline is linked to the control room by cable or telemetry. The increasing power of computer systems available to pipeline operators enables ever more sophisticated pipeline supervision and control. Current technology enables pigs and product parcels to be tracked. Leak detection on pumping pipelines by mass/volume balance or dynamic modeling is becoming increasingly reliable and accurate. Monitoring of pressure (and temperature) also ensures a leak detection capability for enclosed pipelines. The instrumentation monitors variables such as pressure, flow, and temperature in the pipeline and external conditions such as ground movement and air temperature. The control centre staff are trained and qualified to use this information to control and operate the pipeline within the design constraints. Automatic alarms on the pipeline are also linked to the control room to alert the staff in the event of an emergency. The control room staff are trained in emergency procedures and have available an emergency service callout list, full technical details of the system, and spillage control systems. Records are kept of the full operating history of the pipeline and of all maintenance carried out. No work is permitted on a pipeline or in its vicinity without a permit to work issued by the control room and approved by an authorized engineer.

Inspection and maintenance

F4.3 Routine inspection and maintenance is carried out to ensure that the pipeline is mechanically sound and operating at optimum efficiency. Regular surveys are undertaken to check for corrosion and remedial work is carried out if necessary. All instruments and cathodic protection systems are checked for correct operation. Deposits are removed from the internal pipe wall with scraper pigs to reduce pressure losses in the pipeline.

External inspection and maintenance

F4.4 Indications of the need for external maintenance could come from a number of sources, such as a survey to monitor any changes in the voltage levels at the cathodic test points, or inspection pig data. Cathodic protection surveys can detect deterioration in the external coating or outside interference on the electrical system. Indications of corrosion on the exterior of a pipeline necessitate excavation the pipeline at that point and local assessment of the corrosion. Repairs to the outside of the pipe can then be carried out if necessary. Since the excavation and inspection of the pipe is an expensive operation, considerable expertise in assessing the early indications of external corrosion has been developed over the years.

Internal inspection and maintenance

F4.5 There are several methods for checking the condition of the internal wall of a pipeline, including corrosion coupons, intelligence pigs, and iron counts. The highest uncertainty for the fitness-for-purpose analysis is often in the assessment of the degradation rate, particularly in the case of corrosion. Although corrosion is often localized and dependent on on-site conditions, and corrosion rates are not linear in time, various methods have been developed to assess the corrosion-induced rate of pipeline deterioration. Some operators have developed corrosion models to predict $C0_2$ corrosion rates. Though these models have been refined to take, for instance, velocity effects and scaling into account, they still provide a conservative prediction. Various monitoring and inspection tools are used to assess the actual corrosion growth rate. Internal corrosion growth can be assessed using corrosion coupons or probes, or external measurement devices like mechanized ultrasonics and field signature monitoring. A corrosion coupon is a strip of metal inserted into a pipeline that is then periodically monitored for corrosion either by electrical methods or by periodical removal and weighing. This can be performed with the pipeline in service. Unfortunately, the corrosion growth is underestimated when these measurement devices are not located at the worst corrosion spots. A common method to detect internal corrosion is the monitoring of the quantity of dissolved iron in the small quantities of entrained water. The accuracy of the method is dependent on the water pH and the level of iron in the liquid. This method is particularly useful in indicating the level of effectiveness of the inhibitors commonly added in oil pipelines. It is not used in isolation, but in combination with other methods of corrosion monitoring, as each method complements the other and provides supporting data on the condition of the pipeline. Another option to assess corrosion growth is comparison of two intelligence pig surveys. Conventional cleaning pigs are used to scrape away any deposits that have accumulated on the interior wall of the pipeline to reduce pressure loss.

Intelligence pigs

F4.6 Intelligence pigs are used on a regular basis to assess the condition of pipelines. Intelligence pigs provide information on the extent and severity of defects over the entire length of the pipeline, which is a major advantage compared to other techniques. Such pigs can be passed through a pipeline during normal service and use specialized instrumentation to record information on the condition of the pipeline. The pipeline has to be designed to accommodate the type of pig envisaged. Constraints on pig use are typically found in older pipelines; for example, tight bend radii, variable pipeline diameters, and open branches off the main pipelines. Various types of pigs can be used to locate and quantify pipeline geometry defects, such as dents or buckles, and locate and quantify wall metal loss caused by internal or external corrosion, erosion, or mechanical damage. The most frequently used intelligence pigs detect metal loss, for example due to corrosion. The measurement principle of these tools is either based on ultrasonics or on magnetic flux leakage (MFL). A more recent development is a high-frequency eddy current pig to detect low-level internal corrosion in small diameter, heavy wall pipelines. Other regularly applied intelligence pigs aim to detect mechanical damage such as dents, wrinkles, buckles, and ovality. Intelligence pigs detect metal loss due to corrosion with varying degrees of reliability and accuracy. A number of specialist service companies continue to develop the capabilities of their intelligence pigs. Increasing sophistication enables the more accurate sizing and location of corrosion defects. The need for intelligence pigs that can detect cracks was identified a number of years ago and several projects have been carried out to develop such pigs. Pigs capable of detecting cracks are now available but not as yet for all sizes of pipelines. The inspection capabilities of intelligence pigs are continuously improved by developments in sensor technology and in data processing, storage, and analysis. Capabilities and limitations of magnetic and ultrasonic tools are shown in Table 1.

Table F1.1Intelligence Pigs: Differences between Magnetic and Ultrasonic Tools

Magnetic tools	**Ultrasonic tools**
Available diameters < 4”	Available diameters < 6”
Indirect measurement	Direct measurement
All fluids possible	Only homogeneous liquid (slug)
Smooth metal loss difficult	Narrow pits difficult
Verification/calibration often required	No verification (except external defects vs laminations)
Sizing capability 20% wall thickness	Sizing 1 mm
Maximum wall thickness limit	Minimum wall thickness limit
Moderate cleaning required	Thorough cleaning required
Tool speed range 0.5–4 meters/second	Tool speed 1–2 meters/second

Source: Pipeline Oil Spill Prevention and Remediation in FSU, DNV, 1997

Despite improvements in the mechanical design of pigs and inspection technology, intelligence pigs should not be used indiscriminately. Different assessment tools and guidelines are required to determine the acceptability or otherwise of the various types of defects. Each different technique and tool has inherent limitations, and selection should therefore be based on the inspection requirements.

Surveillance

F4.7 Surveillance of a pipeline is achieved by regular patrols. Depending on the terrain, vegetation, length of line to be covered, and local legislation, these patrols may be made from the air or on the ground. They check the condition of the easement and the pipeline markers and identify any activity in the vicinity of the pipeline. Aerial patrols have historically relied on visual observation and written reports; however, recent developments of video technology allow permanent records of the condition of the pipeline route to be made for further analysis. On sections of pipelines prone to ground movement, suitable monitoring of the ground and the pipe is carried out.

Control of third-party interference

F4.8 In most countries, regulations stipulate notification prior to commencement of major excavations and building works within a specified distance of the pipeline. This gives the pipeline operator the opportunity to object to developments that may affect his pipeline. If work must be undertaken near a pipeline, the pipeline operator will advise of the precautions necessary to ensure the integrity of the pipeline system. In most instances it is essential that such work be witnessed by a supervisor employed by the pipeline operator. A wide range of techniques is used by various pipeline operators to diminish the risk of damage to pipelines by third parties.

F5. Leak detection

F5.1 Although spillages are in fact very rare, leak detection systems are installed to detect and locate a leak as soon and as accurately as possible. These systems allow the operator to take the appropriate action to control and reduce the spillage. Detection techniques are based on either continuous or intermittent measurements of specific parameters. Intermittent leak detection methods are often able to detect smaller spillage rates compared to continuous leak detection techniques. Some continuous techniques can only detect transient pipeline conditions during the onset of a leak, and will not be able to identify the presence of a leak at a later moment in time.

F5.2 For some intermittent techniques, fluid transportation through the pipeline needs to be interrupted. Using such intermittent techniques, the detection time of a leak will be completely dependent on the frequency of inspection. The conflicting balance of sensitivity to leaks and false alarms will determine the sensitivity of the leak detection system. Large leaks can normally be detected more rapidly than small ones. However, in order to retain the user’s confidence in the system, system performance should be continually monitored. False alarms should be reduced, leak detection time should be made as short as possible, and the minimum detectable leak rate of a leak detecting system should be as small as possible.

F5.3 The performance of pipeline leak detection techniques is dependant on fluid type, operating pressure (including fluctuations), mode of operation (batch or continuous), pipeline length and size, metering accuracy, and so forth.

The decision as to which technique to adopt depends on a detailed case-by-case evaluation. When the consequences of a spillage are considered serious, more sophisticated techniques of leak detection are required. It may be necessary to deploy more than one leak detection technique in order to achieve the desired leak detection performance.

Principles and methods

F5.4 Although there are numerous leak detection methods available, the detection principles are limited and can be summarized as follows:

- ?? visual observation and other off line leak detection methods;
- ?? comparison of input volume with output volume;
- ?? analysis of pressure or flow rate measurement;
- ?? monitoring of characteristic signals generated by a leak; and
- ?? leak detection pigs.

A summary of the capabilities and application areas of the various leak detection techniques is given in Table F.2.

Table F1.2. Capabilities and Application Areas of the Various Leak Detection Techniques

Leak detection method	Leak detection capability	Mode of operation	Response time	Leak location capability	Remarks
Low pressure	Major leaks	Any	Seconds to minutes	Between block valves if pressure readings available	Commonly used, high thresholds to avoid false alarms
Pressure decrease/ flow increase	Large leaks	Steady state	Seconds to minutes	Between block valves if pressure readings available	
Pressure gradient along the pipeline	Large leaks	Steady state	Minutes	Between block valves if pressure readings available	Onshore only
Negative pressure wave	Medium leaks	Steady state	Seconds to minutes	Within 1 km	Detects only the onset of the leak
Wave alert	Small to medium leaks	Steady and transient state	Seconds to minutes	Within 1 km	Detects only the onset of the leak
Volume balance	Medium to large leaks	Steady state	Minutes to hours	None	
Corrected volume balance	Small to medium	Steady and transient state	Minutes to hours	None	
Dynamic simulation	Small leaks	Steady and transient state	Minutes to hours	At best, within 10% of pipeline length	
Statistical leak detection	Small leaks	Steady and transient state	Minutes to hours	Indication only	Low probability of false alarm
Ultrasonic leak detection pig	Small leaks (typical 50 1/h)	Intermittent	Depends on pigging frequency	Within 100 m	
Acoustic reflecto-metry	Large leaks (on-line), small to medium leaks (shut-down)	Steady state	Depends on monitoring frequency	Within 1 km	
Differential static pressure	Small leaks (hard liquids)	During shut-down	Hours to days	None, between block valves	Capabilities depend on length and temperature effects
Sniffer tube, hydrocarbon sensing cables	All fluids, including multiphase: small leaks	Any	Hours	Within 100 m	Short lines only

Source: Pipeline Oil Spill Prevention and Remediation in FSU, DNV, 1997

Visual observation

F5.5 Where spillages have occurred they have often been detected through visual observation, either by company operators or by people passing by. The source of spillage is not always easy to locate because of the migration of oil through the ground. The distance between the location of the leak and the site where the traces of oil are discovered varies depending on soil conditions and nature of the terrain. Visual observations can often generate false alarms because the spillage may be due to sources other than the pipeline, such as unauthorized disposal of products similar to that in the pipeline.

Comparison of volume input with volume output

F5.6 If the condition of the product in a pipeline were perfectly constant, the volume pumped into the line would exactly equal the volume flowing out. Any difference between the two volumes would signify a leak. The condition of a product entering a pipeline is, however, subject to variation in volume due to changes in temperature, pressure, and density as the product is transported in the pipeline. The size of spillage that can be detected is dependent upon the accuracy with which these changes can be measured. The volumes of product flowing into and out of the pipeline are measured by flow meters at each end of the pipeline, which compensate for temperature and pressure fluctuations. Variations of the product within the pipeline can either be estimated at preset comparison times from measurements of the variables, at regular intervals along the pipeline, or predicted by computer model. The difference between the quantities flowing into and out of the pipeline is corrected to take account of the variations within the pipeline. If the difference exceeds a preset limit an automatic alarm is given. The more often a comparison is made, the faster a leak will be detected. However, this technique does not locate the leak; nor does it necessarily detect small, slow leaks. If there are large changes in elevation in the pipeline profile, a condition called "slack line" can develop. In these sections the pipeline may not be full of liquid, which may cause difficulties in applying volume comparison.

Analysis of pressure and flow-rate measurements

F5.7 The flow of a product through a pipeline produces a pressure drop along the pipeline that is directly related to the flow velocity. Deviation from the expected flow velocities and pressure drops in normal operation can therefore indicate a leak. The operator monitors the pipeline for such variations and an automatic alarm is raised if the change exceeds a set limit. Small variations in measured conditions can also be caused by sources other than leak and consequently the accuracy is related to the size of the leak. It is becoming possible to generate a computer model of the pipeline behavior, and if the measurements received deviate significantly from the computer model, an alarm is raised. This technique does not generally locate the leak. Recent experience of such modeling techniques indicates that these systems may not reliably detect leaks for more complex multi-ingress, multi-egress pipeline systems transporting multiple products. Static pressure tests can be performed while the pipeline is shut down in order to confirm its integrity.

Monitoring of characteristic signals generated by a leak

F5.8 A suddenly ocucurring leak in a pipeline generates a transient negative pressure wave that travels away from the leak location in both directions at the velocity of sound (approximately 1,000 meters/second in crude oil.

F5.9 Detectors located at regular intervals along the pipeline will detect immediately the negative pressure wave and will give an estimate of the location of the leak. However, pressure transients generated by upstream and downstream facilities can cause false alarms so that a sophisticated system is required to eliminate spurious signals. Small and slowly developing leaks cannot be detected by this method.

Leak detection pigs

F5.10 Liquid escaping under pressure through a defect in the pipeline wall generates ultrasonic noise. This noise can be measured and recorded by a pig propelled through the pipeline by the normal flow of the product. Even small leaks can be detected and located with a good level of accuracy. This method will not alert the operator immediately the leak occurs; nor will it indicate the size of the leak. The technique is therefore used for locating and assessing suspected leaks, or conversely, to confirm the integrity of the line.

Appendix G: Geographic and Environmental Data

General

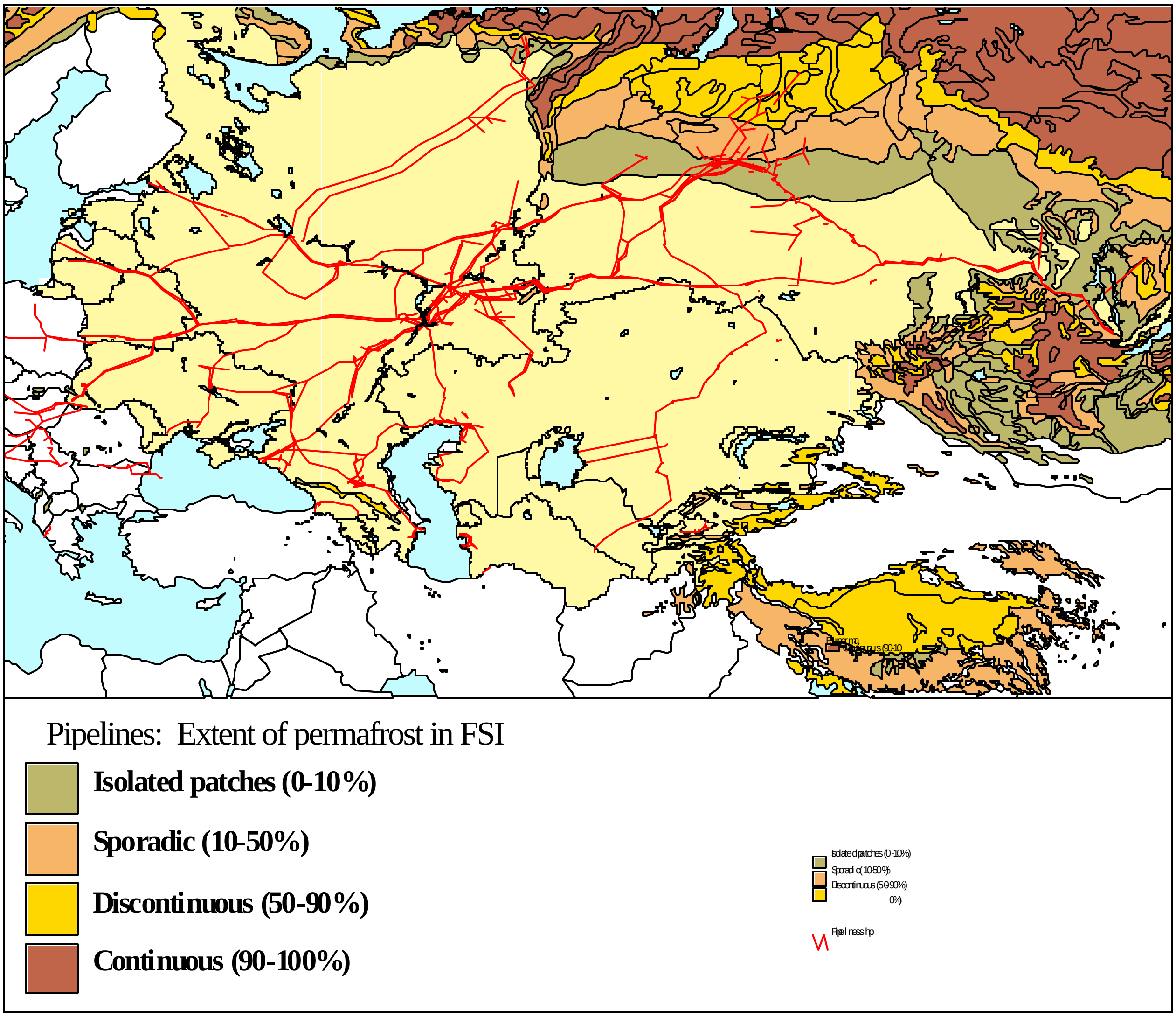
G1.1 To carry out accurate environmental impact or risk assessment it is vital to have knowledge of the temporal and spatial distribution of the biological resources, as well as their vulnerability to the given activity in the short and the long term. This project, being a desktop study, has not included a thorough data collection. It has therefore not been possible to give a sufficiently detailed description or listing of all relevant environmental features in the FSU. In the following paragraphs, a brief description is given of selected environmental features and vulnerable resources in the area. The information is compiled from international literature and from earlier projects that have been carried out by DNV in the FSU. The overall FSU area may be divided into two major regions; *the arctic region* and *the region south of the Arctic Circle*, with the main separating feature being the permafrost.

The Artic Region of Russia

Terrestrial Environment

G2.1 Northern Russia is made up of enormous steppe-like tundra and forested areas (taiga) characterized by large, contiguous, and relatively intact habitats (in other words, wilderness areas). Given the limited number of of large physical structures, (building infrastructure, etc.) the North Western part of Russia represents the largest remaining wilderness in Europe. The mainland is dominated by taiga (boreal forest) in the south and by tundra in the north. The natural feature that most strongly determines the landscape character in the north is the permafrost (Figure G.1). Where there is continuous permafrost the ground is frozen up to a depth of 400 meters. During summer, approximately 1-meter of the permafrost melts, creating a poorly drained, often marshy landscape. There are no trees or bushes on land with continuous permafrost. The area is known to hold significant populations of naturally occurring species, and highly productive and healthy marine ecosystems (Hansen et al.1996). The uniformity of the Arctic provides only a limited range of biological habitats. The number of plant and animal species adapted to this environment is accordingly low. Prospering from lack of competition, large and important populations of saltwater and anadromous fish, seabirds and other waterfowl (particularly in the summer), and marine mammals are sparsely distributed all over the Arctic coastal waters. Low temperature, short growth seasons and few decomposers of biological material result in long restitution periods and processes, making the region vulnerable to human impact (Brunvoll et al. 1994). On tundra large impacts such as vehicle tracks on thawed ground remain visible for decades. Slow re-vegetation and lack of competition mechanisms make the flora in the Arctic highly vulnerable to physical disturbances such as oil pollution or oil spill clean-up operations (Hansen et al. 1996).

Figure G1.1 The Distribution of Permafrost, Continuous and Discontinuous, in the European Arctic.



Source: The International Permafrost Association.

Arctic marine areas

G2.2 The marine ecosystems of the Arctic region are characterized by large stocks of a few key species at each trophic level, while the ecosystems of the more boreal regions have a higher number of species at each trophic level. The production is generally high all over in the shallow Barents Sea. The coasts of the Barents Sea and the islands within it are strongly linked to the marine ecosystems, and also improve the productivity and diversity of the terrestrial ecosystems in these Arctic areas. Unlike the species-rich ecosystems found in the tropical region and stable terrestrial ecosystems, the marine ecosystems of the Arctic are dynamically unstable.

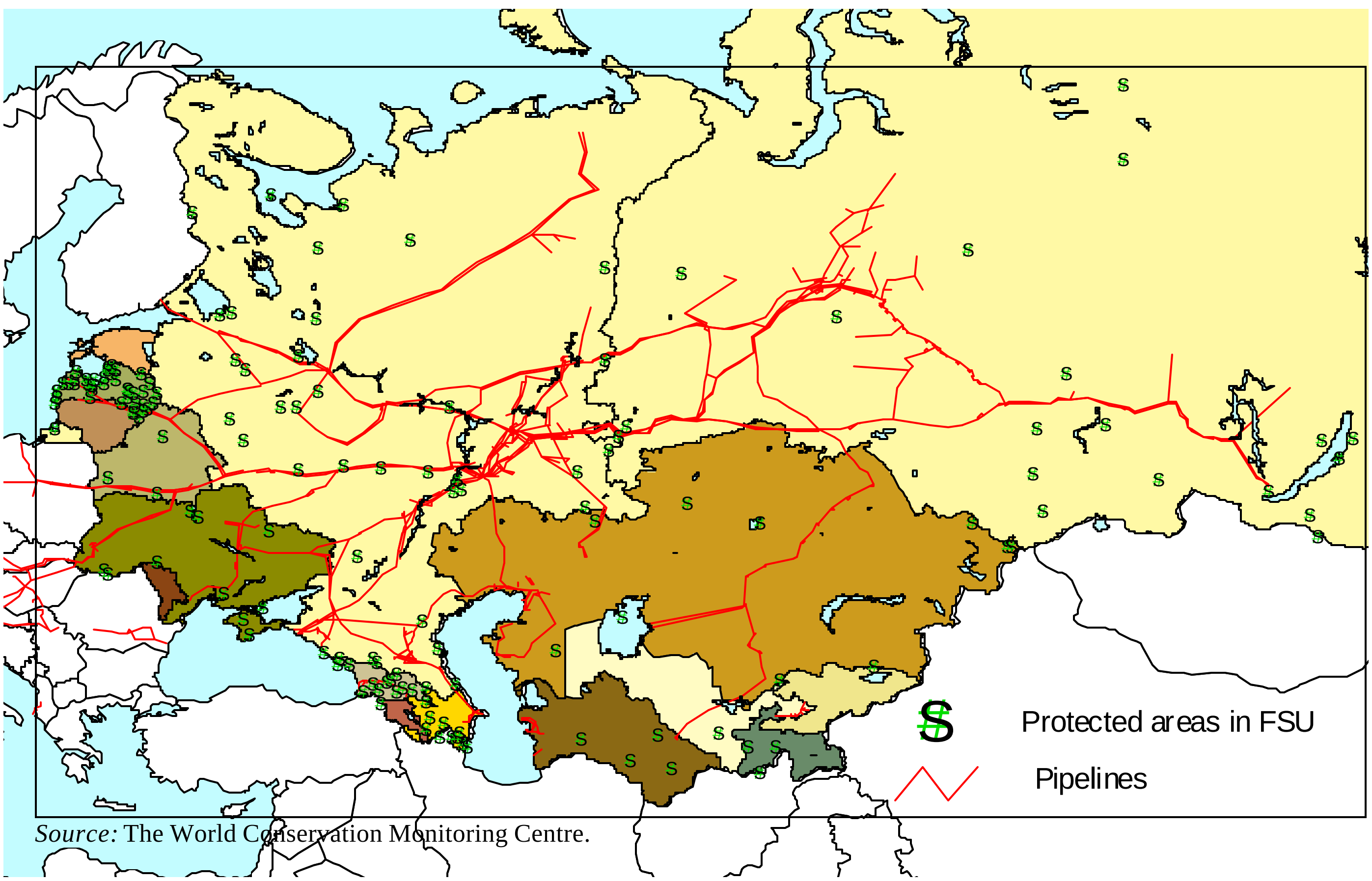
G 3 Protected areas

G3.1 A number of areas are protected or proposed protected at a national or international level. Many areas are designated protected due to their value to birdlife; several others are protected due to their total ecological interest, considering both botanical and zoological values.

Protected areas in FSU include nearly all main types of landscapes, mountain and forest tundra, northern taiga, and polar deserts. According to the International Union for the Conservation of Nature (IUCN) and the Ramsar convention, there are proposals for further protection of several areas. (The The International Union for the Conservation of Nature or IUCN is one of the world's oldest international conservation organizations. It was established in Fontainebleau, France on October 5, 1948 as the "International Union for the Protection of Nature" or IUPN. The Ramsar Conventions on Wetlands, was signed in Ramsar, Iran in 1971.)

Except for some areas, like the recently protected Taimyr "Great Arctic" reserve, most of the northern Russia wilderness is not protected by environmental regulations. Recently, significant efforts within CAFF have aimed to improve this situation.

Figure G.2 Location of Some of the Protected Areas in the FSU



Source: The World Conservation Monitoring Centre.

G.4 Rivers and estuaries

G4.1 The big rivers in FSU create large estuaries and deltas. In northern Russia these rivers provide almost all of the fresh water that enters the Arctic Ocean. Important rivers that flow into the southeastern Barents Sea and the White Sea are the Pechora and Dvina. Compared to other rivers that run into the Arctic region (such as the Ob, Yenisey, and Lena) these are relatively small, but contribute about 9.5 percent of the river drainage into the Arctic Ocean (Hansen et al. 1996). Some of the largest rivers in FSU drain to the south. Examples are the Volga and Kura, the latter of which empties into the Caspian Sea and is the largest river of Transcaucasia.

G 5 The inland seas

The Black Sea

G5.1 The Black Sea is one of the largest enclosed water bodies in the world. FSU nations with a shoreline on the Black Sea are the Russian Federation, the Republic of Georgia, and the Republic of Ukraine. The surface area of the sea is approximately 4.2×10^5 km^2 and it has a volume of about 537×10^3 km^3 (Sorokin 1983). The isolation from adjacent waters results in anoxic conditions below a depth of about 150 meters, enclosing about 87 percent of the total water volume. Thus, life in the Black Sea is restricted to surface layers where the water contains dissolved oxygen (Oguz et al. 1992) (ref. /8/). The principal importance of the area for sea birds is for passage and wintering. Several of the species present in winter are considered to be of international importance by virtue of small or declining populations. Commercially important fish species are sprat, anchovy, whiting, and horse mackerel.

The Caspian Sea

G5.2 The Caspian is the largest enclosed water body in the world and is located on the border of Europe and Asia. Its shoreline extends for 5,360 kilometers, and is divided between the independent states of Azerbaijan, the Russian Federation, Kazakhstan, Turkmenistan, and Iran. The geological history and long-term isolation of the Caspian from the world's oceans have resulted in a unique ecosystem. However, since the early 1920s more than 30 species have been introduced either intentionally or unintentionally. Several of these species are now abundant. The Caspian seal is the world's smallest seal and is endemic to the Caspian. The International Union for the Conservation of Nature (IUCN) classes it as "vulnerable." There are some 120 species of fish in the Caspian, of which sturgeon, salmon, shad, kilka or sprat, and carp are of greatest commercial importance. Caspian fisheries seem to have steadily declined from a level of 430,000 metric tons in the early 1930s to 210,000 metric tons in 1995. he lagoon and coastal areas of the Caspian Sea are internationally important ornithological areas because of the particular species found and the large total numbers of birds. The Caspian lies on a migration route used by numerous waterfowl, which breed to the north and winter either in the southern Caspian region or further south. It has been estimated that not less than 10 million birds pass through the coastal zone annually.