DEPARTMENT OF TRANSPORTATION

Office of Pipeline Safety Operations

[Docket No. 76–12W]

TRANS-ALASKA PIPELINE

Anticipated Petition for Waivers

Alyeska Pipeline Service Company (Alyeska) has advised the Department of Transportation that it expects to petition the Director of the Materials Transportation Bureau for waivers of provisions applicable to the construction of liquid pipelines. Alyeska is the company formed by the owners of the trans-Alaska pipeline system to design, construct and operate the pipeline. In its advice to the Department, and in testimony before cognizant Congressional Committees in mid-July 1976, statements made on behalf of Alyeska have included the following information:

Late in the summer of 1975 it came to the attention of Alyeska and to officials of the State of Alaska, the Department of the Interior and the Department of Transportation, that there were possible problems with the quality of girth welds, made in the field to joint adjacent sections of pipe, and with the radiographic record of girth welds made during the 1975 construction season. Alyeska undertook a reexamination of its 1975 weld and radiograph programs. It determined that of the welds that were accepted in 1975, some 3,995 welds were apparently not radiographed in conformance with applicable requirements, or were radiographed and found to be not in conformity with the Bureau's construction standards (49 CFR Part 195), and in particular, the requirements for weld acceptability, weld repair, and replacement of defective welds.

Of the approximately 1,400 radiographic defects initially determined, it subsequently appeared that some 307 related to welds which had been scheduled for 1975 but had, in fact, not been made. Another 237 welds have now been radiographed by Alyeska. Of the remaining radiographic deficiencies, there are 61welds for which there is not any radiograph on file, and of that number, 21 are identified by Alyeska as being in "critical areas." Additionally, another 59 radiographic deficiencies, or a total of 80, are both in critical areas and significant in nature. Alyeska includes in the "significant" category radiographs which purport to be of two or more welds but are, in fact, duplicates of one weld.

A total of 2,552 welds were found by x-rays to have discontinuities in excess of the criteria set forth in section 6 of the American Petroleum Institute Standard for Welding Pipelines and Related Facilities (13^{th} ed. 1973) (API–1104), which is incorporated by reference in 49 CFR 195.228, or other variations from the construction standards set forth in Subpart D of 49 CFR 195. As of recent date, remedial work has been undertaken on more than half of those defective welds, leaving a balance of 1,235. Of that figure, some 760 welds are located in "critical areas" meaning, according to Alyeska, under riverbeds, in permafrost, or in other areas of difficult access or environmental sensitivity.

The radiographic deficiencies are measured against the requirement for radiographic inspection of all main line girth welds, which is set forth in Section 3.2.2.3 of the Stipulations for the Agreement and Grant of Right-of-Way for the Trans-Alaska Pipeline, entered into by the United States, acting through the Secretary of the Interior, and by the owner-permittees, but could also be discrepancies in the program intended by Alyeska to demonstrate compliance with 49 CFR 195.234. Since paragraph (a) of §195.234 provides that nondestructive testing may be performed by any process that will clearly indicate defects affecting weld integrity, use of other accepted techniques for nondestructive testing could meet the Bureau's requirements, but would be at variance with the Stipulation. Alyeska has not explicitly indicated whether it will petition the Department of the Interior for any amendment to or other relief from the present requirements of the Stipulation. In an August 5 news release, however, Alyeska announced that "it has suspended, pending further review, its efforts to develop an acoustic imaging system as an independent tool for examination of buried welds." That news release also stated that Alyeska now believes "the necessary additional development of the system and its acceptance by the government agencies as an independent tool could not occur within the time remaining for construction of the pipeline."

Alyeska has stated its belief that the 1,235 welds, including the 760 located in areas of "critical" access, do not pose a risk to the safety and integrity of the pipeline. Accordingly, it is to be anticipated that Alyeska will apply for waivers with respect to all or a substantial portion of those welds. Although the Bureau is not yet in receipt of any such waiver request, Alyeska has announced in its August 5 news release that it "will apply at this time for exceptions to strict pipeline weld specifications for 11 welds buried beneath rivers" and "* * * that other applications may be filed later." It is expected that Alyeska will not request a waiver for any weld containing a crack.

It is anticipated that in support of its petition(s) Alyeska will present the results of tests being conducted by or for the British Welding Institute. Those tests are intended to establish fracture toughness, by use of crack opening displacement (COD) method, and impact toughness, by use of the Charpy notch test. Further, Alyeska is expected to present a fracture mechanics analysis that is intended to demonstrate mathematical relationships between dimensions of defects of various types and the associated risks of crack formation and crack propagation. Those relationships may be stated as functions of the length, depth and orientation of weld defects or arc burns and, in some cases, functions of other characteristics such as the radial (weld depth) location. Depth, orientation and location may be either estimated by interpretation of radiographs or measured by use of ultrasonic techniques.

In this connection, the National Bureau of Standards (NBS) is serving as technical consultant to the Bureau's Office of Pipeline Safety Operations. The NBS will prepare an analysis of test procedures and methodology, and an assessment of the adequacy of the statistical data base. It will also prepare its own evaluation of any submitted fracture mechanics analysis, including specifically, provision for safety margins, taking into consideration projected normal operating conditions, abnormal loading, fatigue cycling, corrosion fatigue cycling, anticipated temperature ranges, and other environmental conditions. The NBS evaluations and analyses will be made part of the record of proceedings on any petition that relies upon the fracture mechanics concept.

Thus, the anticipated petition(s) and

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the proceedings thereon may raise issues requiring analysis of interrelated technical problems. This Notice is accordingly published to bring the nature of those problems to the attention of interested Federal and State agencies and other interested persons at the earliest practicable time.

Further, since the nature of the anticipated petition(s) is unusual and the number of weld deficiencies to be addressed may be large, this Notice sets forth a preliminary determination of the information and data required for processing any request for a waiver to allow girth weld defects or arc burns greater than allowed by 49 CFR Part 195, Subpart D, on the basis of a fracture mechanics concept.

REQUIREMENT I—EVALUATION OF PROPOSED ALTERNATIVE MAXIMUM ALLOWABLE WELD DEFECT AND ARC BURN SIZES

Discussion. Alternative allowable defect sizes should be proposed applicable to each type of defect, other than cracks, for which a waiver is being requested. If a waiver is being requested for any arc burns, allowable arc burn sizes should be proposed. Proposed alternative allowable weld defect and proposed allowable arc burn sizes must be supported by fracture mechanics analyses using the worst case fatigue stress spectrum. For analysis, these defects must be assumed to be surface cracks equal in size to twice the proposed allowable weld defect or arc burn size (in both length and depth). These assumed defects must not grow in size such that stressing to the maximum credible service stress could cause leakage. The crack growth analyses must account for both cyclic and sustained stresses in the most deleterious service environments and temperatures.

For weld defects the final output of the analysis shall be a proposed allowable defect size curve with weld defect depth (Y axis) versus weld defect length (X axis); defects having sizes which fall below this curve will be within the proposed acceptance limits. For arc burns, the final output of the analysis shall be a proposed allowable arc burn size curve with arc burn depth (Y axis) versus arc burn length (X axis); arc burns having sizes which fall below this curve will be within the proposed acceptance limits. Requests for waiver of any weld defects or arc burns which fall above their respective curve must be the subject of separate submittals, as describe[d] in Requirement III.

SUPPORTING INFORMATION AND DATA

1. A minimum fracture toughness value for the pipeline shall be established by documenting the fracture toughness in sufficient notch locations and temperatures for the weld metal and the heat-affected zone that is representative of the pipeline welds and, in the case of arc burns, for the base metal. The toughness value used in the fracture mechanics analyses shall be the minimum toughness at 10°C below the minimum anticipated service temperature.

2. A maximum fatigue crack growth rate for the pipeline shall be established by documenting the fatigue crack growth behavior of the weld metal and the heat-affected zone that is representative of the pipeline welds and operating conditions and, in the case of arc burns, representative of the base metal. The fatigue crack growth rate used in the fracture mechanics analyses shall be the maximum fatigue growth rate multiplied by an assumed safety factor of four.

3. A minimum threshold for sustained load crack growth shall be established by documenting for each of the service environments the sustained load cracking behavior of the weld metal and the heat-affected zone that is representative of the pipeline welds and, in the case of arc burns, representative of the base metal. The minimum threshold established shall be used as a terminal condition for the fracture mechanics analyses.

4. The worst case fatigue stress spectrum, the worst case instantaneous credible stress, and the appropriate residual stress, all representative of pipeline welds and heat-affected zones shall be used in the proposed allowable weld defect analysis. Similarly, the worst case of hoop stresses shall be used in the proposed allowable arc burn analysis. Documentation of stress analysis methodology and derivation is necessary for proper assessment of the operating and residual stresses.

5. Any request shall contain relevant documentation of the material property data. This includes tensile, elastic, impact, and corrosion properties of the weld, heat-affected, and base material at appropriate temperatures and environments.

REQUIREMENT II—EVALUATION OF INDIVIDUAL DEFECTS OR ARC BURNS FOR WHICH WAIVER IS REQUESTED AGAINST ALLOWABLE DEFECT AND ARC BURN SIZES ESTABLISHED UNDER REQUIREMENT I

SUPPORTING INFORMATION AND DATA

1. In the case of weld defects, inspection data shall be provided for each individual weld for which a waiver is requested. These data shall include defect type, location and dimensions (length and depth). The methodology used to obtain these data shall also be described. The dimensions of non-planar defects such as porosity and slag inclusions may be determined from radiographs; uncertainties in these measurements and differences in interpretations shall be described. The length of planar defects, such as lack of penetration or lack of fusion, may also be determined from radiographs; uncertainties in these measurements and differences in interpretations shall be described. The depth of planar defects should be determined by a nondestructive test method specifically designed for depth measurement, such as ultrasonics reflection methods. If radiographs are used to determine the depth of planar defects, an additional assumed safety factor of two shall be applied to the estimated depth.

2. In the case of arc burns, inspection data shall be provided for each individual arc burn for which a waiver is requested. These data shall include the location and the maximum length and depth of the arc burn heat-affected area. The methodology used to obtain these data shall also be described. The length of heat-affected areas may be determined from radiographs; uncertainties in these measurements and differences in interpretations shall be described. The depth of each heat-affected area shall be determined by estimating on a conservative basis the depth of other arc burns of representative severity using appropriate metallographic examination techniques and applying an additional assumed safety factor of two to this estimated depth.

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REQUIREMENT III—EVALUATION OF SPECIAL CASES NOT MEETING ALLOWABLE DEFECT OR ARC BURN SIZE CRITERIA ESTABLISHED UNDER REQUIREMENT I

Discussions. Separate submittals are required to establish alternative acceptance standards for defects and arc burns that exceed the allowable size criteria that may be established on the worst case basis for Requirement I. This submittal must be based on the fatigue stress spectrum, environment and location of the defect under consideration. All other technical requirements are the same as specified in Requirement I.

The inspection data provided for each individual weld defect or arc burn shall include the maximum width of that defect or arc burn. The width of weld defects and arc burns may be determined [in] the manner described in Requirement II for determining the length of weld defects and arc burns.

For the most critical combinations of weld defects, arc burns and operating conditions, full (or large) scale tests may be required to demonstrate that the pipeline retains an acceptable level of integrity.

Supporting Information and Data. Except as described in the discussion above, the supporting information and data requirements are the same as specified for Requirements I and II.

Docket No. 76–12W is being established in the Office of Pipeline Safety Operations, 2100 Second Street, SW., Washington, D.C. 20590, at this time to receive any written views or comments that interested persons may wish to submit based on the general discussion of the anticipated waiver petition(s), the statement of evaluation requirements and the description of the required information and data set forth in this Notice. Upon receipt of a petition for waiver from Alyeska, the Bureau will publish a supplemental notice in the **FEDERAL REGISTER** under this docket number describing the petition, making it available for public inspection and inviting public comment on the specific requests made in the petition.

Persons planning to file comments on this Notice or on the anticipated petition(s) who wish to be served with copies of future notices issued by the Bureau in this matter may file with the Docket Clerk at the above address a request to be placed on the Notice Mailing List for Docket No. 76–12W.

All comments received will be considered and will be made available in the docket for public inspection along with the petition(s) and related analyses for public inspection upon receipt.

(18 U.S.C. 831–835, 49 CFR 1.53(g).)

Issued in Washington, D.C., on August 12, 1976.

CESAR DELEON,
Acting Director, Office of Pipeline Safety Operations.

[FR Doc. 76–23938 Filed 8–12–76; 11:35 am]

DEPARTMENT OF TRANSPORTATION

Materials Transportation Bureau, Office of Pipeline Safety Operations

[OPSO Docket No. 77–6]

TRANS-ALASKA CRUDE OIL PIPELINE

Waiver on 13 Repaired Girth Welds at Valdez Terminal

By petition dated June 1, 1977 (follow-up confirmation of a verbal request made on May 6, 1977), the Alyeska Pipeline Service Company (Alyeska) requested that a waiver be granted from the requirements of 49 CFR 195.230 and 49 CFR 195.232 for 13 repaired girth welds in the Trans-Alaska Pipeline System (TAPS) in the Valdez terminal. Those girth welds are in the terminal piping represented in the Fluor Ocean Services, Inc., drawing "D–50–M1558," dated August 9, 1976, Valdez Terminal, Crude System—B31.4 49 CFR 195 and drawing "D–50–M1559," dated August 9, 1976, Valdez Terminal, Crude, Crude Transfer and Relief ANSI–B31.4. The 13 repaired girth welds are listed below in Table 1, setting forth pertinent information relative to each weld. There were nonconformance reports issued on 11 of the 13 welds by the Alaska Pipeline Office of the Department of the Interior for not meeting Department of Transportation (DOT) standards. The other two were not acceptable by Alyeska Quality Assurance for not meeting DOT standards.

Table 1

Repaired Girth Welds Subject to Waiver Request

Weld No.	Connection	Size	DOT Section Violated*	Description of Violation	APO NCR	Design Pressure	Operating Pressure	Test Pressure	Aboveground Belowground
743	E11 to E11	48"	(2) (4)	two repairs	--	275	50	550	A/G
946	Pipe to valve	48"	(1) (3)	repair crack	4125	275	50	550	A/G
948	E11 to valve	48"	(1) (3)	repair crack	4126	275	50	550	A/G
1039	Tee to valve	48"	(1) (3)	repair crack	4125	720	200	510	A/G
1043	Tee to valve	48"	(1) (3)	repair crack	4125	720	200	720	A/G
1051	E11 to valve	48"	(1) (3)	repair crack	4125	720	200	510	A/G
121C	Pipe to pipe	36"	(2) (4)	two repairs	4126	275	50	550	A/G
203	Pipe to pipe	36"	(2) (4)	two repairs	4126	275	50	550	A/G
327	Pipe to pipe	36"	(2) (4)	four repairs	4126	275	50	550	A/G
622	Pipe to pipe	48"	(2) (4)	two repairs	--	720	200	740	B/G 25'
723	Pipe to pipe	48"	(2) (4)	two repairs	4126	275	50	550	A/G
963	Pipe to pipe	48"	(2) (4)	two repairs	4126	275	50	550	A/G
1121	Pipe to pipe	48"	(1) (3)	repair crack	4126	275	50	550	A/G

* The listed numbers correspond to sections as follows:
(1) - §195.230(a)(1)
(2) - §195.230(a)(2)
(3) - §195.232(a)
(4) - §195.232(c)

As Table 1 indicates, 6 of the 13 welds contained cracks which are not allowed to be repaired by DOT standards. The remaining seven were repaired more than once at the same weld location which is likewise not allowed by DOT standards. In each of the above two instances, DOT standards require the weld in question to be completely removed, the ends rebeveled, and a new weld made.

In performing the repairs to the 13 welds, Alyeska followed its established procedures for the repair of welds not subject to the regulations in 49 CFR Part 195 since it believed, at that time, that these welds were not subject to the regulations. Since that time, it has been established that the lines containing these welds are clearly subject to the regulations in 49 CFR Part 195.

In support of its petition, Alyeska states that the repaired cracks and multiple repair of defects provide an adequate level of safety and protection and should not be required to be removed for the following reasons:

With respect to girth welds connecting two fittings or a fitting and a valve (weld numbers 743, 946, 948, 1039, 1043, and 1051):

1. The existing weld cannot be removed, the ends rebeveled, and new welds produced since in each case the joint design would be altered precluding the production of a sound weld. Moreover, since the manifold piping is rigid, tied into concrete, and cannot be shifted for a new lineup, the spacing remaining after removal and rebevel would be too great to produce a sound weld.

2. The cost and time required to obtain replacement valves would be prohibitive. It takes approximately six months to obtain replacements for 49-inch valves which are unique to the trans-Alaska pipeline. In the case of 36-inch valves, the procurement time would be only slightly less.

3. Each replacement fitting would take approximately six months to obtain since fittings of [t]his size are also unique to the trans-Alaska pipeline.

4. The valves and fittings involved are located in manifolded assemblages of several valves and fittings lacking adequate work space for their removal without disassembly of perhaps the entire manifold.

5. If one fitting is replaced with another fitting, the range of dimensional tolerances of the fittings would make matching lineup extremely difficult and perhaps impossible without further disassembly of the manifold assembly. For example, the length

dimension of a replacement tee could vary by as much as : inch.

6. The repair procedures in Alyeska welding specification SWP–100AP used in repairing these girth welds were developed in accordance with the guidelines in the repair procedures in American Petroleum Institute Standard 1104 (API 1104), Section 7.

7. The weld repairs were conducted under closely controlled conditions. They were closely monitored and documented, and all documentation including radiographic records of each repair are available for review.

8. As indicated in Table 1, each repaired girth weld has been pressure tested far in excess of the operating and design pressure of the pipeline.

9. Because spillage due to a failure from these girth welds would be within the confines of the terminal, a leak could be quickly detected and repair crews quickly mobilized to contain and stop the spillage.

With respect to girth welds connecting one section of pipe to another section of pipe (weld numbers 121C, 203, 327, 622, 723, 963, and 1121):

1. Except for girth weld number 622, each of these girth welds is located within a diked area so that any spillage due to a failure would be contained by the dike and the environmentally sensitive Valdez area would not be affected. Furthermore, a leak could quickly be detected and repair crews quickly mobilized to stop the spillage.

2. Weld number 622 is buried 25 feet deep and the excavation and repair of this girth weld would be extremely costly.

3. The repair procedures in Alyeska weld specification SWP–100AP used in repairing these girth welds were developed in accordance with the guidelines in the repair procedures in API 1104, Section 7.

4. The weld repairs were conducted under closely controlled conditions. They were closely monitored and documented, and all documentation including radiographic records of each repair are available for review.

5. As indicated in Table 1, each repaired girth weld has been pressure tested far in excess of the operating and design pressure of the pipeline.

A representative of the Office of Pipeline Safety Operations (OPSO) has inspected the girth welds in question and found that the circumstances described by Alyeska in support of its petition for waiver to be accurate.

The OPSO, through cooperation with the Energy Research and Development Administration (ERDA), had its contractor, Rockwell International, examine Alyeska's radiographs of the 13 original welds and each of the repaired welds. As a result, Rockwell radiographic experts have confirmed that (1) the defects indicated in Alyeska's documentation were correctly identified, (2) each of those defects has been removed, and (3) none of the repaired girth welds now contains any defect.

The OPSO has also noted that since these girth welds are in the network of terminal piping, flow in these lines can easily be diverted to other lines in the event of a failure, thereby facilitating the repair of such leaks.

It is also appropriate to point out that the OPSO has recently granted to Michigan-Wisconsin Pipeline Company (Michigan-Wisconsin) a waiver from the regulations regarding the removal of cracks in girth welds. In evaluating the petition for that waiver, OPSO concluded that the extensive testing conducted by Michigan-Wisconsin established that cracks can be adequately repaired by following the repair procedures called for in API 1104, Section 7. The repair procedures followed by Alyeska in repairing the 13 welds for which this waiver is requested are essentially those employed by Michigan-Wisconsin.

After review and deliberation of all the information submitted by Alyeska, and other relevant information, MTB finds that a waiver from the applicable provisions of 49 CFR 195.230 and 195.232 for the 13 welds in question is appropriate and consistent with pipeline safety for the following reasons:

1. With regard to all 13 girth welds:

(a) The existing welds have been found by ERDA radiographic experts to be free of defects;

(b) The welds have withstood a hydrostatic test without leakage or failure at pressures far in excess of what they will be subjected during operation; and

(c) The repairs to the welds were made under closely controlled conditions with various levels of inspection by the contractor, Alyeska, and the Federal government further assuring established procedures were followed during repair and sound welds exist.

2. With specific regard to the girth welds that connect two fittings or a fitting to a valve (weld numbers 743, 946, 948, 1039, 1043, and 1051).

(a) If the weld was removed and a new weld made, the problems with proper lineup, excessive space to be filled with weld metal, and destruction of the original joint design by rebeveling would result in a weld not as safe as the existing one; and

(b) The excessive cost involved in replacing the valves or fittings is not justified for the reasons cited in paragraphs (1) and (2)(a) above.

3. With specific regard to girth weld number 622, which connects one pipe with another and is buried, the costly 25-foot excavation to reach that girth weld for replacement is not justified for the reasons cited in paragraph (1) above.

4. With specific regard to the other girth welds that connect one pipe to another pipe (weld numbers 121C, 203, 327, 723, 963, and 1121), even in the unlikely event of a leak in any of these welds, the spillage would be contained and not create an environmental problem or safety hazard since each weld is located within a diked area.

Accordingly, effective immediately, the Alyeska Pipeline Service Company is hereby granted a waiver from compliance with the requirements of 49 CFR 195.230(a) and 49 CFR 195.232(a) and (c) for the 13 girth welds listed in Table 1.

(18 U.S.C. 831–835; 49 CFR 1.53 (g).)

Issued in Washington, D.C., on June 3, 1977.

JAMES T. CURTIS, Jr.,
Director, Materials Transportation Bureau.

[FR Doc. 77–16346 Filed 6–8–77; 8:45 am]

DEPARTMENT OF TRANSPORTATION

Materials Transportation Bureau

[Docket No. 77–7W]

TRANS-ALASKA CRUDE OIL PIPELINE

Petition for Waiver of Girth Weld Defects

On May 24, 1977, the Alyeska Pipeline Service Company (Alyeska) delivered to the Department of Transportation (DOT) a request for a waiver of the DOT regulations governing the acceptability of liquid pipeline girth welds (49 CFR 195.226 and 49 CFR 195.228). More specifically, Alyeska seeks the waiver for all trans-Alaska crude oil pipeline girth welds containing irregularities interpreted as not complying with the DOT's requirements but which are within the parameters of the fracture mechanics decision curves contained in the DOT's November 26, 1976, decision on a similar but more limited request (41 FR 52933, December 2, 1976). Alyeska would have this new requested waiver apply to girth welds currently known to contain such irregularities as well as those that may be revealed by any current or future review or audit.

In the November 26 decision cited by Alyeska in support of its current request, the DOT, after careful consideration of the issues and the technical advice provided by its experts and consultants, determined that—

Fracture mechanics analysis is acceptable as a basis for granting exemptions from existing standards in appropriate circumstances, if such analysis produces a convincing and conservative estimate of structural integrity.

The specific criteria for applying this determination to the task of accepting or rejecting individual girth welds were set forth in the form of four decision curves in an appendix to the decision.

Originally Alyeska had requested a waiver for 612 of the approximately 30,000 field girth welds performed during the 1975 construction season. That number was reduced to 34 as repairs to the 1975 welds were completed during the construction season of 1976. In all, there are approximately 100,000 main line girth welds in the pipeline—30,000 field welds performed during each of the 1975 and 1976 construction seasons and 40,000 "double joint" shop welds performed at the pipe storage facilities in Fairbanks and Valdez joining two sections of pipe before transporting them to construction sites. Concerns about the quality of girth welds and the adequacy of the quality control system had prompted Alyeska to audit the radiographic records of the 1975 field girth welds during the winter of 1975–76. It was that audit which led to Alyeska's first girth weld waiver request.

with respect to the 34 unrepaired girth weld defects then known to exist, the DOT further determined that those having dimensions which fell below the decision curve for the type of defect concerned "do not constitute a risk of failure at those connecting points during the expected lifetime of the pipeline." The DOT found that 24 of the 34 welds were acceptable on the basis of fracture mechanics analysis. A waiver was granted for only three welds located under the Middle Fork of the Koyukuk River inasmuch as repair efforts on the other 21 were then well on their way to completion.

Shortly after the DOT's November 26, 1976, decision on that request, a new series of questions arose concerning the quality of girth welds that had been performed I the shops at Valdez and Fairbanks. These questions were the subject of hearings before the Subcommittee on Energy and Power of the House of Representatives' Committee on Interstate and Foreign Commerce on December 14, 1976.

DOT Girth Quality Sampling Program

Because of the concerns about the total girth weld population and because of the energy and environmental significance of the trans-Alaska crude oil pipeline, the DOT, as indicated during the hearings on December 14, 1976, undertook a statistical sample of the 1975 and 1976 field welds and double joint welds made in the Fairbanks and Valdez shops. A sample consisting of the radiographs for 500 randomly selected welds was chosen from each of the above three categories for a total sample size of 1500. Beginning in March 1977, the radiographs were interpreted by three DOT radiographic specialists. In order to minimize any dependent bias in the interpretation, each of the three radiographic specialists independently reviewed each of the radiographs from a listing of the approximately 100,000 girth welds against the DOT regulatory standard of acceptability as specified in 49 CFR 195.226 and .228. In each case where at least two specialists interpreted a radiograph as indicating an arc burn or a defect, related narrative records and documentation were examined and, two indepenednt [sic] radiographic experts reviewed the specialists' findings. The two radiographic experts, [1] are employees of Rockwell International Corporation under contract to the Energy Research and Development Administration (ERDA).

The ERDA experts, employing a technology used in dealing with the earlier waiver request, determined the depth and length of each defect they confirmed. A detailed report of the three DOT radiographic specialists' and the ERDA experts' findings and measurements has been made a pat of this docket. In summary, the results were as shown in Tables I and II.

TABLE I.—*Welds containing defects identified by DOT specialists*[2]

Type of defects	1975 welds	1976 welds	Shop welds	Total welds
Arc burns.....	78	28	21	127
Planar	15	6	5	26
Nonplanar.....	35	9	0	44
Total welds[3] ..	88	37	24	149

TABLE II.—*Welds containing defects identified by DOT specialists: Con-*

[1] Wayne D. Stump, manager of nondestructive testing, at the Rocky Flats Plant of Rockwell International (Prime U.S. ERDA contractor), where he has been employed for 25 years, holds a BS in Physics from the University of Denver and is a registered professional engineer in Colorado. Mr. Stump is a 25 year member and fellow of the American Society for Non-destructive Testing and has held several section offices in the Society. He is a certified ASNDT Level III in several test methods including radiography, and serves on the National Certification Panel for Level III personnel. He also holds membership in the American Society of Metals and the National Management Association.

John L. Summers, nondestructive testing area manager, at the Rocky Flats Plant, Rockwell International (Prime U.S. ERDA contractor), where he has been employed for the past 25 years, holds an associate degree of Science from Mascatine Junior College and has completed additional studies at the University of Colorado. Mr. Summers is a 22 year member and fellow of the American Society for Nondestructive Testing, having held several section offices in the Society. He is a certified ASNDT Level III in several test methods including radiography, and has served on the select Ad Hoc committee for Level III certification and is currently on the national Certification Panel for Level III personnel. He has been nominated as a National Director for ASNDT. Mr. Summers also holds membership in the American Society of Metals and the National Management Association and is a registered professional engineer in the State of California.

[2] This does not include indications of external undercuts. The depth of external undercuts which are often detectable by radiography cannot be evaluated by that technique. For this reason Alyeska, as is the standard practice in pipeline construction, employed visual external inspection to gage the depth of external undercuts and require repair when their dimensions exceeded DOT limits.

[3] The sums of the addends are less than the totals because some welds contain more than 1 class of defect.

firmed and measured by ERDA experts

Type of defects	1975 welds	1976 welds	Shop welds	Total welds
Arc burns	70	23	18	111
Planar	13	5	1	19
Nonplanar	31	9	0	40
Total welds[3] ..	72	28	18	118

FRACTURE MECHANICS ANALYSIS

As indicated in the DOT's November 26, 1976, decision on Alyeska's earlier waiver request, fracture mechanics is the study of the effects of defect size and orientation on the ability of a structure containing cracks to resist fracture. It permits quantitative estimation of the growth of cracks during the lifetime of the structure and is currently used in the design of aircraft and space vehicles, electrical power generating equipment including nuclear pressure vessels and ship cargo tanks used to carry liquefied natural gas. More recently it has been recognized by Lloyd's Register of Shipping (London, England) and Det Norshe Veratas (Oslo, Norway) to resolve critical questions relative to pipeline safety.

It was after a comprehensive review of all relevant material assembled during consideration of that earlier waiver request and following extensive consultation with its experts and consultants including a panel of distinguished public experts that the DOT concluded in November 1976, that fracture mechanics could serve as a basis for granting waivers from existing DOT standards without compromising pipeline integrity.

Using the measurements (length and depth) of each confirmed defect as determined by the ERDA experts and applying them to the fracture mechanics decision curves contained in the DOT's November 26, 1976, decision, the results are as shown in Table III.

TABLE III.—*Analysis of confirmed defects in 1,500 randomly selected girth welds based on November 26, 1977 decision curves*

Types of defects	Welds analyzed	Welds not acceptable			Welds found acceptable
		1975	1976	Shop	
Arc burns	111	3	0	0	108
Planar	19	0	0	0	19
Nonplnar	40	5	0	0	35
Total welds[3]	118	8	0	0	110

Although the question before the DOT on Alyeska's earlier waiver request concerned only a portion of the total main line girth welds, the conclusions reached and the accompanying decision curves developed for worst possible case situations are no less valid and applicable for the total pipeline. For this reason, I have decided to extend the applicability of that earlier decision to cover the entire 800-mile main line of the trans-Alaska crude oil pipeline and thereby grant the requested exemption from compliance with DOT welding standards (49 CFR 195.226 and 195.228).

WELDS NOT ACCEPTABLE UNDER NOVEMBER 26, 1976 FRACTURE MECHANICS DECISION CURVES

Being convinced of the adequacy and structural integrity of all girth welds meeting fracture mechanics criteria as represented by the November 26, 1976, decision curves, there remains, however, a question as to those welds containing defects which pass neither the DOT standards nor the decision curve criteria. The weld quality sampling program results list eight such welds all performed during the 1975 construction season.

The true value of any sample lies in its utility as evidence of the quality or character of the whole or entire lot. Thus, using the results of the girth weld sampling program, it is possible to make certain estimations regarding the total number of girth welds containing defects which fall beyond the limits of the November 26, 1976, decision curves. Applying statistical sampling formulae calculated to provide a 99 percent level of confidence, leads to an estimate that 0.1 to 0.9 percent (0.5%±0.4%) of all girth welds fall into this category.

Moreover, the individual sample defect length and depth measurements made by the ERDA experts, when displayed on the decision curves, provide an indication of the probable range of deviation and the maximum likely deviation of all such defects above the acceptable fracture mechanics determined sizes.

As noted in the November 26, 1976, decision, Figures 5 and 6, several sets of decision curves were proposed for evaluating the acceptability of planar and nonplanar flaws. The curves selected for use as part of that decision were the most conservative choices although the panel of five national experts convened by the DOT in October 1976 recommended otherwise. The panel in its November 8, 1976, report noted that the least conservative curves (i.e., the Irwin curves) "will most closely predict actual failures of non-crack defects." Moreover, in the decision itself, it was pointed out that while all DOT and outside experts agreed that fracture mechanics can serve as a basis for granting waivers, there are differences among those experts as to the degree of conservatism required, specifically as regards the choice of analytical models and factors of safety. Notwithstanding the technical merits of any particular model, it was the most conservative model that was chosen to carry out the November 26 decision.

To assist the DOT in evaluating this information and determining its significance to the structural integrity of the pipeline, on June 6, 1977, the DOT reconvened the panel of five experts first convened in October 1976, in connection with the initial consideration of fracture mechanics technology. The panel of experts and their areas of expertise were: Dr. Herbert T. Corten, Professor of Theoritical [sic] and Applied Mechanics, University of Illinois (expert in fracture mechanics analysis); Dr. Matthew Creager, President of Del West Associates (expert in fracture mechanics analysis and testing); Dr. Robert C. McMaster, Regents Professor of Welding and Electrical Engineering, Ohio State university (expert in metallurgy, welding, nondestructive testing and radiography); Dr. Warren F. Savage, Professor of Metallurgy and Director of Welding Research, Rensselaer Polytechnic Institute (expert in metallurgy and welding); and Edward Criscuolo, Naval Surface Weapons Center (expert in welding and radiography).

That panel of experts concluded that:

1. The successfully concluded hydrostatic test, while useful in testing longitudinal welds and serviceability is not a significant test of girth welds;
2. The sampling program met the objective of determining with a high level of confidence whether or not the quality of welds meets DOT standards;
3. The November 26, 1977, decision curves, as they had previously noted, contain more than adequate safety factors;
4. None of the eight welds containing defects, which are only marginally outside the acceptable range of the November 26 decision curves, pose any threat to the structural integrity of the pipeline through its anticipated life;
5. Girth weld failures, which are generally an unlikely source of potential problems, will be even less so in the case of the trans-Alaska pipeline considering the superior materials and weld systems employed;
6. In view of the strong evidence that the 1976 field welds and the shop welds do not contain any defects which exceed the limits of the November 26 fracture mechanics decision curves, further review of these welds is not war-

ranted; and

7. Since the defect indications of the 1975 field welds are of neither sufficient size or number to be of concern with regard to structural integrity, further review of the radiographs of these welds will not furnish any additional useful information or increase the structural reliability of the pipeline.

A complete report of the panel's evaluation and recommendations has been placed in the public docket.

On the basis of the results of the sampling program, the technical analysis of those results by the panel and DOT experts, and the application of fracture mechanics analysis to these results, I have concluded that there is no more than an extremely remote risk of loss of pipeline integrity.

Accordingly, I have determined that further DOT review of the girth weld radiographs and related documentation will not serve any useful purpose and that any program to seek out and repair any girth welds would certainly prove costly and quite possibly environmentally disruptive with no perceptible likelihood of enhancing the structural integrity of the pipeline.

(18 U.S.C. 831–835, Section 6(e)(4) of the Department of Transportation Act (49 U.S.C. 1655(e)(4)) and Section 203 of the Trans-Alaska Pipeline Authorization Act (Pub. L. 93–153).)

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ALAN A. BUTCHMAN,
Certifying Officer, OPSO.

MARGARET E. HAMMOND,
Deputy Secretary of Transportation.

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