

STATUS OF THE ENVIRONMENTAL PROTECTION AGENCY'S
NEVADA TEST SITE EXPERIMENTAL DAIRY HERD
January 1, 1969 - December 31, 1970

by
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Monitoring Systems Research and Development Division
National Environmental Research Center

U.S. ENVIRONMENTAL PROTECTION AGENCY
Las Vegas, Nevada

Published June 1973

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ABSTRACT

The Environmental Protection Agency's National Environmental Research Center, Las Vegas, maintains an experimental dairy herd in Area 15 of the Nevada Test Site. The status of this herd, for the period January 1, 1969 through December 31, 1970, is described. The report lists changes and improvements made on the facilities; presents herd and individual production and reproduction statistics; details health problems and treatments; and summarizes the metabolism, field, and "ad hoc" research studies that involved the dairy herd.

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INTRODUCTION

The National Environmental Research Center, Las Vegas of the Environmental Protection Agency has maintained an experimental dairy herd in Area 15 of the Nevada Test Site since 1964. Previous reports have detailed the establishment of the experimental farm⁽¹⁾, the status of the herd from May 22, 1964 to July 1, 1966⁽²⁾, and from July 1, 1966 through December 31, 1968⁽³⁾. Also published were annual reports on agronomic aspects of the farm^(4,5). Details of the history of the farm and herd, of the management methods, and of the experimental operating procedures were discussed in these reports⁽¹⁻⁵⁾.

This report presents information and data on production, reproduction, veterinary medicine, and experimental involvement of the dairy herd during the period January 1, 1969 through December 31, 1970. Also mentioned are changes in herd management and facility improvements.

FACILITIES AND EQUIPMENT

There were no major additions to or modifications of the basic facilities and equipment at Area 15 as described in previous reports^(1,2,3). Minor improvements of the barn during 1969 and 1970 included the repainting of the interior walls of the milking parlor and sample room, the resurfacing of the floors of the metabolism area with a nonskid sand-epoxy mixture, and the pouring of a concrete approach slab at the entrance of the holding pens.

The green chop feed bunks were lowered and widened to allow easier feeding and to decrease feed loss. The wooden posts of the exercise lots were set in concrete and painted with linseed oil to increase their useful life.

The cow lots were scanned periodically with an electromagnet for the removal of wire, nails and other metallic debris.

A 60 kv transformer was installed in the Quonset area so that electrical service could be provided to the storage Quonset and to the gasoline tank.

Annual maintenance inspections of the milking system were performed by a factory representative of Babson Brothers.

The Area 6, Well 3 barn and corrals were modified to provide a facility for necropsies and metabolism studies. The remodeling included the removal of the original milking stanchions, the rewiring of the electrical system and addition of a larger transformer panel, the addition of a restroom and shower, and the construction of four metabolism stalls. Additional concrete pads were poured at the entrances to the necropsy room and under the waterers in the lots. The wooden mangers were removed and replaced with mangers fabricated from 60 foot 3/8-inch steel tanks. The wooden corral gates were replaced with custom 1/2-inch pipe gates.

ANIMAL HUSBANDRY

General Information

As of December 31, 1970, there were 28 mature Holsteins and 5 mature Jersey cows in the dairy herd (see Appendix I). Four cows remained of the original herd of 17 cows purchased in 1964. The five Jersey cows were purchased from the Mill's Jersey Farm of Fallon, Nevada, on November 6, 1969. During 1969 and 1970, 14 Holstein cows and one Holstein bull entered the herd from the replacement breeding program. Twelve animals were removed from the herd through terminal experiments or from death through natural causes.

The lactating cows, the breeding bull, and newborn calves were maintained at the Area 15 facilities. Nonlactating cows, weaned calves, and replacement heifers were maintained at the Well 3, Area 6 facilities. Figure 1 shows the location of these facilities on the Nevada Test Site.

Milking procedures followed those generally used by commercial dairies in the intermountain area, except that the cows were milked at 9- and 15-hour intervals to reduce labor requirements. Also bucket milkers were used rather than a pipe-line system in order that individual milk samples could be collected without cross-contamination and to document individual production data. The record keeping and the routine and experimental milking procedures were detailed previously⁽²⁾.

The dairy cows were maintained in the lots and were not allowed to graze. All forage was brought to them in the form of alfalfa or rye green chop (raised on the Area 15 farm) or as alfalfa hay (purchased or raised at Area 15)^(4,5). In addition to the roughage, the lactating cows were fed commercial 14% protein supplement at each milking. Table 1 presents selected nutritional components of feed fed to the dairy cows. Details on feeding procedures were published previously^(2,3).

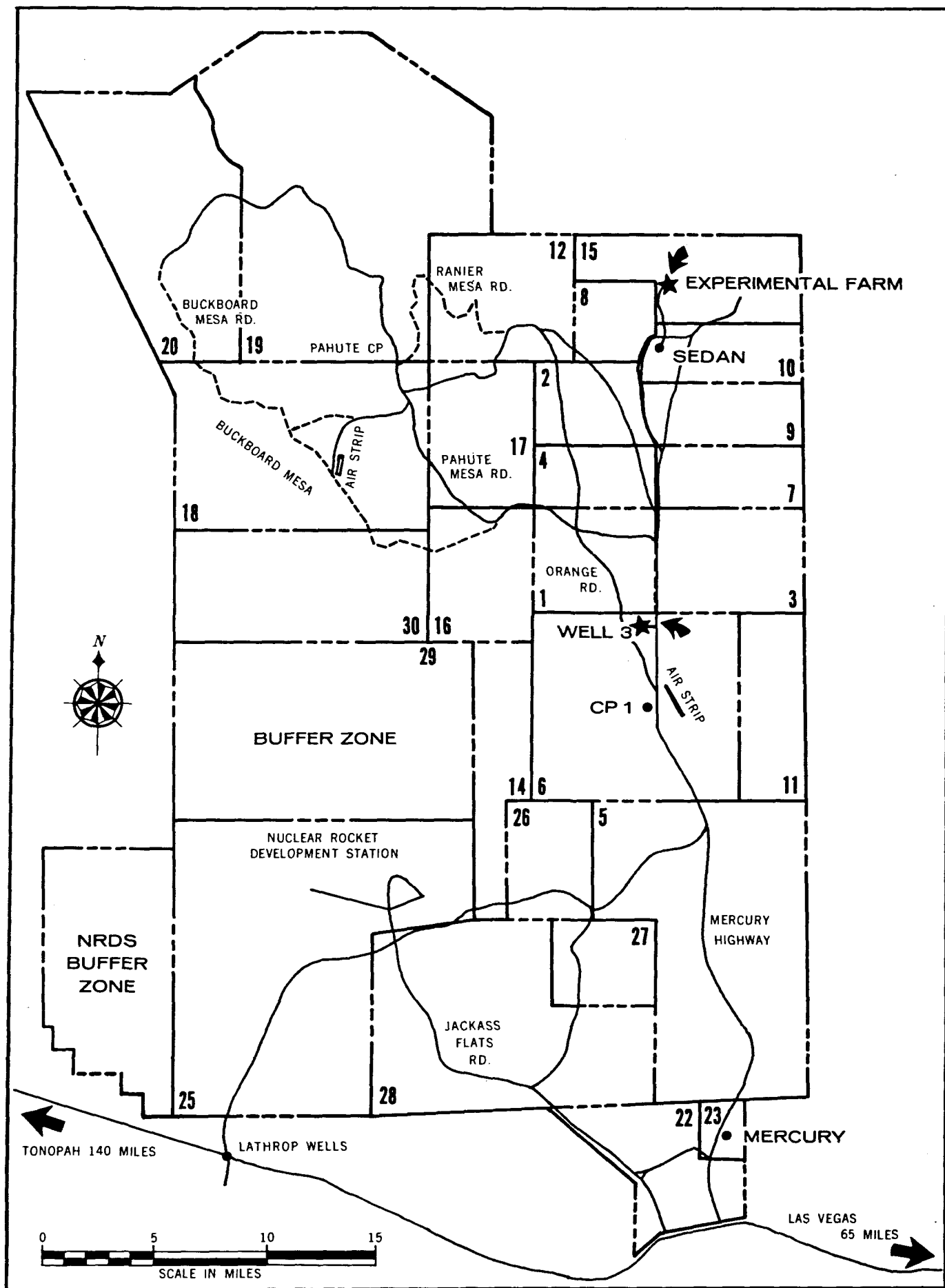


Figure 1. Location of Environmental Protection Agency facilities on the Nevada Test Site.

Table 1. Selected Nutritional Components of Feed Fed to Dairy Herd

Type and Source of Feed Date of Analysis	% Protein	% Fat	% Fiber	% Calcium	% Phosphorous	ppm Cobalt	ppm Copper	ppm Manganese	ppm Molybdenum	ppm Iodine
Alfalfa Hay - Area 15 Mar. 1969	15.2	1.5	23.8	1.1	0.3	3.0	11.0	24.0	5.0	<1.0
Purchased Alfalfa Hay - Olof Barhard Mar. 1969	17.5	1.6	26.9	1.1	0.3	2.0	16.0	25.0	4.0	8.0
Commercial Concen- trate supplement Mar. 1969	16.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.0
Commercial Concen- trate supplement June 1969	16.2	3.5	4.9	1.6	0.5	N/A	N/A	N/A	N/A	<1.0
Alfalfa Hay - Area 15 Feb. 1970	19.4	1.6	23.7	1.8	0.2	2.5	15.0	33.0	7.0	280
Purchased Alfalfa Hay - Ron Floyd Feb. 1970	17.4	1.3	25.7	2.2	0.2	2.0	18.5	42.3	7.4	260
Commercial Concen- trate supplement Feb. 1970	15.3	3.4	5.8	0.7	0.5	2.5	22.6	177.0	N/A	<1.0

Production

Between January 1, 1969, and December 31, 1970, there were 47 complete lactations recorded (see Appendix II). The production averages were as follows: Length of lactation, 272 days; milk production, 13,333 pounds; butterfat percentage, 3.9%; and butterfat production, 520 pounds. These production figures were similar to those recorded for July 1966 - December 31, 1968 (270 days; 13,330 pounds; 3.5%, and 449 pounds) and compared favorably with production statistics for the State of Nevada and for the United States as compiled by the Statistical Reporting Service of the United States Department of Agriculture. During 1969 the average production in Nevada was 10,072 pounds of milk and 363 pounds of butterfat per cow; for the United States, it was 9,166 pounds of milk and 337 pounds of butterfat per cow. During 1970, the Nevada average was 10,216 pounds of milk and 363 pounds of butterfat per cow; the United States' average was 9,388 pounds of milk and 347 pounds of butterfat per cow.

Reproduction

The ideal reproductive cycle for a dairy cow would be conception after one breeding, with parturition at nine months, followed by an open period of approximately 60 days before rebreeding. The lactation period should last about 305 days with a rest or dry period of approximately 60 days before calving and the repetition of the cycle. As shown in Appendix II, the experimental dairy herd falls somewhat short of this ideal, in that there were 1.9 breedings per conception, the average open period was 110 days, the average lactation period was 277 days, and the average dry period was 108 days.

A variety of factors may adversely affect the reproductive cycle of the cow. These might include hormonal imbalance, unobserved estrus, true anestrus, uterine infections, disease, metabolic disturbances, anatomical defects, faulty breeding techniques, stresses from weather, poor nutrition, etc. Standard management and medical procedures used to prevent or treat these conditions were described previously^(2,3).

The cows were routinely bred by artificial insemination performed by one of the two trained technicians on the farm staff. Natural breeding by a Holstein bull was used on difficult breeders, first-calf heifers, and when a technician was not available.

There were 59 calves born into the herd during 1969-1970 (see Appendix III). Thirteen of these calves were kept as future replacement animals for the herd. Fifteen male or calves of poor breeding were utilized for radionuclide tissue distribution studies. Nineteen male or crossbred calves were excess to experimental needs and were euthanized. Four calves were transferred to another agency. Six calves were stillborn or died shortly after birth

because of dystocia or from exposure to inclement weather. One calf was never found (presumed devoured by coyotes) and one cow aborted a five-month-old fetus following treatment for traumatic gastritis.

All surviving calves born into the herd have been large, vigorous and have shown good growth. One calf (twin to a normal male) was a pseudohermaphrodite.

Four sets of twins were born into the herd during 1969-1970. As shown in Table 2, since the establishment of the herd in 1964, there have been 15 sets of twins in 160 births, for a twinning percentage of 9.4%. This is significantly higher than the normal rate of 2 to 3%^(6,7). Although the exact cause of this high incidence of twinning is not known, it might be explained in part by: 1) an increased genetic disposition toward twinning in certain family blood lines; 2) the above average nutritional plane of the herd; 3) an imbalance in the calcium phosphorus ratio (high calcium, low phosphorus); 4) stress conditions experienced by the cows might upset the normal hormone balance and result in polyovulation; 5) the therapeutic use of estrogen for infertility and breeding problems.

Table 2. Twins Born into Experimental Dairy Herd, May 1964 - December 1970

Calf No.	Sex	Date Born	Dam & Sire	Age of dam at twinning	Remarks
581 AIU 2	Female Male	23 May 1964	Cow #4 Unknown	Unknown	Dam purchased in Idaho in Spring of 1964. No pedigree record.
49 50	Female Male	4 Aug 1965	Cow #27 Bull #508	4 yrs	Dam purchased from Vernon Cantlon, Reno, Nevada, 14 Nov 1964. Willomente and Burke Breeding.
51 52	Female Female	24 Aug 1965	Cow #1 Hereford bull	7 yrs est.	Dam purchased in Idaho in Spring of 1964. No pedigree record.
6 68 69	Male Male	8 Mar 1966	Cow #28 Bull #508	7-1/2 yrs	Dam purchased from Oats Bros., Fallon, Nevada, 14 Nov 1964. Rag Apple Breeding - mother's side.
73 74	Female Male	31 May 1966	Cow #13	5-1/2 yrs est.	Dam purchased in Idaho in Spring of 1964. No pedigree record.
80 81	Female Female	5 Oct 1966	Cow #48 Bull #508	6 yrs	Dam purchased from Oats Bros., Fallon, Nevada, 23 Jul 1965. Monarch and Gallant Breeding. Received estrovarian 9 Dec 1965, 24 days prior to breeding.
101 102	Male Male	4 May 1967	Cow #15 Bull #509	10 yrs est.	Dam purchased in Idaho in Spring of 1964. No pedigree record. Received estrovarian 20 Jul 1966, 5 days prior to breeding.
No num- bers	Female Male	23 Dec 1967	Cow #85 Bull #70	7 yrs	Twins born premature and dead. Dam pur- chased from Oats Bros. Fallon, Nevada, 16 Nov 66. Rag Apple breeding - father's side.

Table 2. Twins born into Experimental Dairy Herd, May 1964 - December 1970 cont'd.

Calf No.	Sex	Date Born	Dam & Sire	Age of dam at twinning	Remarks
130 131	Male Female	13 Jun 1968	Cow #55 Bull #70	3 yrs	Dam was daughter of number 48 and Oats bull.
137 138	Male Female	14 Aug 1968	Cow #84 Bull #70	8 yrs	Dam was half-sister of #85. Purchased from Oats Bros. , Fallon, Nevada, 16 Nov 1966. Rag Apple Gallant Breeding.
142 143	Female Female	20 Oct 1968	Cow #83 AIH-37	6 yrs	Twins stillborn. Dam purchased from Oats Bros., Fallon, Nevada, 16 Nov 1966. Pride - Enchantress breeding.
10 150 151	Male Female	23 Feb 1969	Cow #36 AIH-306	4 yrs	Dam was daughter of Cow #20. Spent entire life on NTS.
163 164	Male Male	21 Jul 1969	Cow #43 Bull #70	7 yrs	Dam was purchased from Cantlon Farms, Reno, Nevada. Not registered because of clerical error. Has some of same blood lines as #43. Sire Willomente Raven Bland.
176 177	Male Female	6 Nov 1969	Cow #44 Bull #70	10 yrs	Twins stillborn. Dam was purchased from Cantlon Farms, Reno, Nevada. Willomente and Burke blood lines. Cow died 14 Jan 1970. Suffered bovine lymphosarcoma.
189 190	Male Male ?	19 Mar 1970	Cow #19 Bull #70	14 yrs	One twin was psuedohermaphrodite with undescended testicles and penis resembled a vagina.

Average 6-7 yrs

VETERINARY MEDICINE AND SURGERY

The major health problems found in the herd were related to the stresses of production (mastitis, metabolic disturbances) and reproduction (infertility, dystocia). An occasional lameness resulted from the close confinement required for certain metabolism studies. No contagious diseases were diagnosed during this reporting period.

Each illness or health problem was diagnosed by a veterinarian and recommended therapy initiated^(2,3). Prophylactic procedures were used where indicated; i.e., routine palpation of the reproductive tract, the dipping of teats in an iodine solution after milking to control the spread of mastitis or the use of poloxalene on feed to prevent bloat. Surgery performed ranged from minor teat surgery to rumenotomy for treatment of traumatic gastritis.

Unproductive cows and cows that failed to respond to treatment, i.e., those with chronic mastitis, severe lameness, etc. were salvaged by utilizing them for terminal studies on the tissue distribution of various radionuclides. Six animals were removed from the herd because of udder pathology, two were removed because of reproductive problems and two because of progressive lamenesses (see Appendix I).

Only one cow died from natural causes during 1969-1970. Her death resulted from tympanites (bloat) which occurred during the evening hours when the herd was unattended. Necropsy of one sacrificed animal revealed the lesions of bovine lymphosarcoma.

The mastitis prophylactic procedures, detection methods, and therapy used in the herd has been described previously.⁽³⁾ During this reporting period, the average monthly incidence of clinical mastitis was 2.6 cases. The dose duration of each case was 3.7 days. The average percentage of the herd injected each day was 1.9 percent.

EXPERIMENTAL PARTICIPATION OF THE DAIRY HERD

During 1969-1970, the dairy herd was utilized for studies which defined the critical metabolic pathways of selected radionuclides which might appear in the environment following a nuclear detonation. The herd was also used for an ingestion study of growing forage which was contaminated by a controlled release of radioiodine under simulated washout conditions. An "ad hoc" study was mounted after the Baneberry Event in December of 1970 which resulted in significant contamination of the Area 15 farm. All metabolism studies and field experiments are listed in Table 3.

Each experimental cow was selected for the metabolism studies on the basis of production, stage of gestation, breed, and health. After selection, the animals were placed in the metabolism stalls for 36 hours prior to dosing for acclumation to experimental procedures. Appendix V lists the cows involved in each study.

The metabolism studies were conducted at the Well 3 facilities in specially designed metabolism stalls that provided continuous restraint of the animals but still allowed sufficient movement for comfort and easy access for milking and sample collection. A feed manger and waterer were incorporated into the stalls. All fecal output was collected in a pan. The entire urine production was collected in a bottle via an indwelling catheter which remained in the urinary bladder for the duration of the experiment.

The cows were usually maintained in the stalls for a period of 8 to 12 days. The selected radionuclides were either administered orally, via gelatin capsules, or intravenously as an isotonic solution. Samples of blood, urine, feces, and milk were collected every six hours until peak levels were found. Sampling then followed a 12-hour schedule. Cull cows

Table 3. Projects Involving the Dairy Herd January 1, 1969 - December 31, 1970

Project	Date	Radionuclide	Dose Administered	Route of Administration
Shimoda	5/13/69	^{123}I	220 $\mu\text{Ci/dose}$	Multiple oral
		^{131}I	30 $\mu\text{Ci/dose}$	
Wolf I	7/24/69	^{187}W	1.0 mCi/dose	Oral
Plum	8/13/69	^{203}Pb	1.5 mCi/dose	Oral
End Point	8/27/69	^{131}I	0.98 mCi/dose 1.11 mCi/dose 1.16 mCi/dose	Oral I.V. Oral
Thallus I	9/15/69	^{202}Tl	0.5 mCi/dose	Oral
Wolf II	10/29/69	^{181}W	0.500 mCi/dose	Multiple oral
Rims I	12/09/69	^{131}I	0.4 mCi/dose	Oral
Lightwater I	12/22/69	^3H	120 mCi/dose	Oral
Thallus II	1/09/70	^{202}Tl	1.5 mCi/dose	Multiple oral
Rims II	2/10/70	^{131}I	0.275 mCi/dose	Oral
Wolf III	3/03/70	^{187}W	1 mCi/dose	Single I.V.
Beryl	4/27/70	^7Be	3.0 mCi/dose	Oral
Rubi	6/15/70	^{86}Rb	2.0 mCi/dose	Oral
Quicksilver	8/03/70	^{203}Hg	1.7 mCi/dose	Oral
Washout	9/29/70	^{131}I		Oral ingestion of aerosol contaminated alfalfa
Ferric	10/19/70	^{59}Fe	2.44 mCi/dose	Oral
Baneberry	12/18/70	Mixed fission products		Inhalation and ingestion of contaminated feed

and excess calves were utilized in terminal studies for determining tissue distribution of selected radionuclides.

Shimoda - May 13 - June 2, 1969

This study was designed to determine the feasibility of using ^{123}I as a tracer to determine the total uptake of iodine when dairy cows were fed alfalfa hay contaminated with ^{131}I .

On May 13, an aerosol of ^{131}I -tagged diatomaceous earth was released over bales of alfalfa hay at Area 15. This contaminated hay was transported to Well 3 where it was fed to three Holstein cows (Nos. 36, 45, and 62) which were confined in metabolism stalls. These cows received measured amounts of this hay from the 16th through the 19th of May. A fourth cow, #71, was administered ^{131}I via a capsule from the 16th through the 19th of May. All four cows received ^{123}I orally. The cows remained in the metabolism stalls through the 23rd when they were returned to Area 15. Milk samples were collected through the 2nd of June.

As the ^{123}I was contaminated with ^{124}I , the objectives of the study were not met.

Wolf I - July 24 - July 28, 1969

The objective was to determine the excretion pathways for ^{187}W following a single oral administration. Blood, feces, milk, and urine were collected from four cows (Nos. 36, 45, 62, and 71) who were maintained in metabolism stalls at Well 3 from July 24 - July 28.

Within 84 hours nearly 80% of the administered dose was recovered with 65% of it eliminated via the feces, 14.6% via urine and 0.4% in the milk.

Data from this study, along with data from the Wolf II and III studies, will be published in the open literature following receipt of final revisions and clearances.

Plum - August 13 - August 25, 1969

The objective of this study was to obtain compartment data in the dairy cow on the metabolism of radiolead following a single oral administration of ^{203}Pb . This gamma emitting isotope has a half-life of 2.2 days and is frequently produced during nuclear detonations. Four Holstein cows (Nos. 36, 46, 62, and 71) were placed in the metabolism stalls at Well 3 on August 13, and remained there through August 18. Blood, feces, urine, and milk samples were collected every 6 to 12 hours during this period. Milk and fecal samples were collected daily from the 19th through the 25th. Over 91% of the administered dose was recovered in the feces within 84 hours. Approximately 0.1% was excreted in urine and less than 0.02% was secreted in milk.

Details and results of the study are published elsewhere⁽⁸⁾.

Endpoint - August 27, 1969

This was a terminal study designed to utilize unsatisfactory dairy cows to obtain information on the kinetics of radioiodine in the major organs and systems of the dairy cow.

On August 27, three lactating Holstein cows (Nos. 12, 86, 92) were placed in the metabolism stalls at Well 3 and administered approximately 1 mCi of ^{131}I . The dose was administered orally to cows 86 and 92 and intravenously to cow 12.

Cows 12 and 92 were sacrificed 12 hours after dosing and cow 86 was sacrificed 24 hours after dosing. The cows were necropsied and samples were collected from every organ and tissue in their bodies.

Data will be published following receipt of final clearances.

Thallus I - September 15 - October 14, 1969

The objective of this study was to determine uptake, secretion, and deposition data on the metabolism of radiothallium following a single oral administration of ^{202}Tl . Five lactating Holstein dairy cows were used for this study. Four cows (Nos. 43, 47, 87, and 21) were placed in the metabolism stalls at Well 3 from September 15 to October 14 for collection of milk, urine, feces, and blood samples. They were then transferred to Area 15 where individual milk and fecal samples were collected. The fifth cow (No. 27) was placed in a separate pen and sacrificed on October 1.

The following parameters were measured for radiothallium in milk:

a) 18 hours to peak activity; b) 30 hours biological half-life; and
c) 3% of the administered dose was recovered in 8 days. The details and results of this study will be presented in the open literature at a later date. Portions of the work were presented at the 16th Annual Health Physics Society Meeting in New York, NY, July, 1971.

Wolf II - October 29, 1969 - January 12, 1970

The objectives of this study were to investigate the retention, secretion, and distribution of radiotungsten in the dairy cow following multiple oral ingestion, simulating the continued ingestion of contaminated forage and to study the retention of radiotungsten in calves fed milk from cows ingesting the radiotungsten.

From October 29 to November 7, 1969, cows 18, 43, 47, and 87 were placed in the metabolism stalls at Well 3 and received two doses of ^{181}W each day. Milk, blood, fecal, and urine samples were collected every six hours while in the stalls. Sampling continued at Area 15 through January 12, 1970.

Calf #169 was fed milk from cows 87 and 43 for six days, sacrificed, necropsied, and sampled on November 3. Calf #154, which was fed milk from cow 87 for 28 days, was sacrificed, necropsied, and sampled on November 25.

Cow #35 and calf #710 were placed in metabolism stalls on November 10 and were dosed twice daily with ^{181}W until their sacrifice on November 14. They were then necropsied and tissues and organs were analyzed.

Cow #18 (one of the metabolism cows) was sacrificed, necropsied, and sampled on December 18, 1970.

Data from this study will be published at a later date in the open literature along with the data collected from the Wolf I and III studies.

Rims I - December 9, 1969 - January 5, 1970

The objective of this study was to determine whether the chemical form of ingested radioiodine affects the amount of radioiodine secreted in milk

and the amount of radioiodine transmitted to the thyroid. On December 9, the Group I cows (Nos. 2, 21, 39, and 171) each received an oral dose of ^{131}I as elemental iodine, Group II cows (Nos. 13, 71, 84, and 172) received ^{131}I as methyl iodide, Group III cows (Nos. 11, 16, 46, and 174) received ^{131}I as sodium iodide, Group IV (Nos. 44, 62, 90, and 175) received ^{131}I as sodium iodate, and Group V cows (Nos. 173 and 26) were control cows. These cows were maintained at Area 15 for the duration of the study.

In vivo thyroid counts were made on each cow during the remainder of the experiment and milk samples were collected at each milking.

Data from this study indicate that both breeds of cows metabolized the different chemical forms of radioiodines similarly. However, the results of the milk and thyroid analysis of the single Jersey cow (171) in the elemental iodine group appeared variant and necessitated repetition of that portion of the study (Rims II). A report on both studies has been published⁽⁹⁾.

Lightwater I - December 22 - May 25, 1970

The purposes of this project, following a single oral dose of tritiated water were to: a) establish the required time for tritium to reach equilibrium in the body fluids of the dairy cows; b) determine the biological half-life of tritium secreted in the milk; and c) determine the fraction of tritium in the various milk components, i.e., serum, fat, and protein. On December 22, 1969, cows 21, 90, 171, and 175 received an oral dose of tritium. The cows were maintained at Area 15 for the entire experiment. Milk and blood samples were collected from the cows periodically until

the experiment was terminated on May 25.

Data from this study and from Lightwater II are being evaluated and will be published in the open literature at a later date.

Thallus II - January 9 - April 1, 1970

The objectives of this study were to measure the milk secretion and fecal and urinary excretion of radiothallium following multiple oral ingestion by the dairy cow and to measure the tissue distribution of radiothallium in calves fed milk from cows ingesting this radionuclide.

Cows 11, 13, 39, and 46 were maintained in metabolism stalls at Well 3 from January 9 through January 19. While in the stalls they received oral doses of ^{202}Tl (100 μCi at time of initial preparation) twice daily for seven days. Two calves were fed milk from cows ingesting radiothallium. Calf #170 was sacrificed on January 20 and calf #178 was sacrificed on January 29. A third calf, #684, was sacrificed on January 20, five days after receiving a single oral dose of 100 μCi of ^{202}Tl . Final milk samples were collected from the cows on April 1.

Data collected from this study and from Thallus I will be published in the open literature at a later date. Portions of the work were presented at the 16th Annual Health Physics Society Meeting held in New York, NY, July 1971.

Rims II - February 10 - February 28, 1970

The results of milk and thyroid analysis of the single Jersey cow in the I_2 group of Rims I appeared variant and necessitated repetition of the $^{131}\text{I}_2$ ingestions with that cow plus two additional Jersey cows

(Nos. 171, 174, and 175) as well as control Na¹³¹I ingestions with two Jersey cows (Nos. 172 and 173). Sampling and in vivo thyroid counting was conducted at Area 15 and continued through the 28th of February.

The results of this study indicated that the finding for cow 171 in Rims I was an artifact and that there were no differences due to breed in the metabolism of radioiodine.

The report on this study and Rims I ("Milk Transfer Comparisons of Different Chemical Forms of Radioiodine") has been published elsewhere⁽⁹⁾.

Wolf III - March 3 - April 1, 1970

The purpose of this study was to evaluate the long-term excretion of radiotungsten and to determine any metabolic difference that occurs following a different route of administration. On March 3, 1970, four Holstein cows (Nos. 2, 26, 83, and 116) were placed in metabolism stalls at Well 3 and administered ¹⁸⁷W intravenously. They were monitored in the stalls until the 6th at which time they were returned to Area 15. Sampling continued through April 1.

Sixty-eight percent of the administered dose was excreted within 80 hours, with over 65% excreted in the urine.

Data from this study and Wolf I and Wolf II will be reported in the open literature at a later date in a paper entitled "Metabolism of Radiotungsten by the Dairy Cow", which is now in the review process.

Beryl - April 27 - May 18, 1970

The objective of this study was to investigate the metabolism with emphasis

on milk transfer, and tissue distribution of radioberyllium following a single dosing.

A single oral dose of ^7Be was administered to each of four cows (Nos. 13, 36, 48, and 83) maintained in metabolism stalls at Well 3. Less than 0.002% of the ingested activity was recovered in the milk. The biological half-time as measured in the milk was 19 hours.

For the tissue distribution studies, one lactating dairy cow (No. 19) was administered a single intravenous dose of ^7Be and three calves (Nos. 181, 183, and 186) were each given a single oral administration. The animals were sacrificed at various time intervals and samples collected for tissue distribution studies. The liver, kidney, and skeletal system were found to accumulate most of the absorbed activity. The bone appeared to be the site of long-term deposition.

The report of this study entitled "Radioberyllium Metabolism by the Dairy Cow" has been published⁽¹⁰⁾.

Rubi - June 15 - July 27, 1970

The objective of this study was to investigate the metabolism of rubidium in the dairy animal and to determine the tissue distribution.

On June 15, 1970, Cows 2, 16, 119, and 123, which were maintained in metabolism stalls at Well 3, were given a single oral dose of $^{86}\text{RbCl}$. Approximately 50% of the administered activity was eliminated within 66 hours. During this time 8% was secreted in milk, 12% in feces, and 30% in the urine.

In a companion study, a lactating dairy cow (No. 90) was administered ^{86}Rb intravenously and three calves (Nos. 189, 191, and 192) were dosed

orally. The animals were sacrificed at various times after administration to measure the tissue distribution of the radionuclide. Deposited activity was highest in the liver, thymus, pancreas, muscle, and other soft tissue.

A report on this study has been accepted for publication by Health Physics. Portions of the work were presented at the 16th Annual Health Physics Society Meeting in New York, NY, July 1971.

Quicksilver - August 3 - September 16, 1970

The objective of this study was to investigate the metabolism and tissue distribution of ^{203}Hg by the dairy cow following a single administration.

On August 6, 1970, four lactating dairy cows (Nos. 36, 62, 122, and 127) were confined in the metabolism stalls at Well 3 and were administered 1.7 mCi of ^{203}Hg as a single oral dose of $\text{Hg}(\text{NO}_3)_2$.

For the next 10 days, all milk, urine, and feces from the four cows were collected and the ^{203}Hg content measured. Peak activity appeared in the milk 42 hours after ingestion of the radionuclide. The biological half-life in milk was 124 hours. During the 10-day period after dosing, 75% of the ingested ^{203}Hg was excreted, with 0.08% recovered in the urine, 0.01% in the milk, and the remainder in the feces.

In a companion study, two lactating cows (Nos. 62 and 85) and three calves (Nos. 193, 194, and 195) were sacrificed at various times after oral and intravenous administrations of ^{203}Hg . Samples were collected to measure the tissue distribution of the radionuclide. The radiomercury was found distributed throughout the body, with the kidneys being the site of

principal concentration. This study indicates that inorganic mercury was sparingly absorbed from the intestinal tract of the dairy cow and the urinary system was the preferred route of excretion for the absorbed mercury.

The report on this study has been written and will be published following receipt of final reviews and clearances. Portions of the work were presented at the 16th Annual Health Physics Society Meeting, New York, NY, July, 1971.

Washout - September 29 - October 19, 1970

The primary purpose of this project was to study, under controlled conditions, the efficiency of the washout process for removal of particulate and gaseous ^{131}I aerosols from air by various intensities of rain. Ancillary studies included the determination of the peak milk to peak forage ratio of ^{131}I for groups of cows fed washout contaminated green chop and dry aerosol contaminated green chop.

Following completion of aerosol generation, contaminated growing alfalfa at Area 15 was green chopped from the dry deposition plot and fed to cows in Group I (Nos. 45, 116, and 122) and that from the plot that received a moderate washout was fed to cows in Group II (Nos. 16, 84, and 127). The rest of the herd (Group III) received green chop from uncontaminated plots.

The study groups were fed their assigned ration for eight days. Final milk samples were collected on October 19.

The data from this study were included in the report "Radiation Prediction Model for Field Events", which is in the final review processes.

Ferric - October 19 - December 31, 1970

The objectives of this study were to establish the milk transfer and to investigate the metabolism of ^{59}Fe by the dairy cow following a single oral administration.

Four lactating cows (Nos. 13, 46, 122, and 127) were confined in metabolism stalls at Well 3 and administered 2.4 mCi of ^{59}Fe as $^{59}\text{FeCl}_3$ in a single oral dose. For the next four days, all milk, urine, and feces from the cows were collected and the ^{59}Fe content measured. A peak activity concentration of 0.00018% per liter appeared in the milk 51 hours after administration and was eliminated by the cow with a biological half-life in milk of 172 hours. Fifty percent of the ingested radioiron was eliminated in 30 hours. During this 30-hour period, more than 99% of the excreted iron was recovered in the feces. Transfer to milk was limited with less than 0.015% of the administered nuclide secreted in 10 days. In a companion study, one cow (No. 171) was administered radioiron intravenously. The peak activity concentration in milk of 0.026% per liter occurred 33 hours after administration and decreased with an early biological half-life of 84 hours and a later one of 180 hours. The results of these studies indicate absorption and milk transfer of iron by the dairy cow is relatively slight.

The report of these studies has been written and will be published following receipt of final revisions and clearances. Portions of this work were presented at the 16th Annual Health Physics Society Meeting held in New York, NY, July 1971.

Baneberry - December 18 - December 31, 1970

The Baneberry Event, detonated on December 18, 1970, in Area 18 of the Nevada Test Site, resulted in the accidental release of significant amounts of radioactivity. A portion of this cloud passed over the Area 15 farm. An "ad hoc" metabolism study was initiated as soon as entry was permitted.

The ^{131}I studies for this event were planned to accomplish the following objectives:

1. differentiate between inhalation and inhalation plus ingestion as reflected by radioiodine in milk;
2. measure urinary and fecal concentrations of radioiodine from a combined inhalation/ingestion exposure (metabolism study); and
3. measure concentrations of ^{131}I and other fresh fission products in various tissues of calves living in this contaminated environment.

To accomplish the objectives the procedures used were enumerated in the same order as above.

1. Four lactating cows (Nos. 13, 87, 127, and 134) were separated from the herd and fed uncontaminated hay ("inhalation" group) and two other cows (Nos. 11 and 119) were fed contaminated hay. The six cows were maintained at Area 15 and were milked twice daily. Individual records were kept on milk production and feed consumption.
2. Four lactating cows (Nos. 16, 45, 46, and 123) were selected from the dairy herd and placed in metabolism stalls at Well 3, NTS. Contaminated bales of hay from Area 15 were chopped to provide a homogeneous source of forage for these cows. The concentration

of ^{131}I was measured in the hay, milk, urine, and feces for a period of six days, then they were returned to the dairy farm.

3. Two calves (Nos. 202 and 205), exposed to the cloud and ingesting contaminated hay and milk, were sacrificed four days after the start of exposure and selected tissue samples were obtained for analysis.

Data from studies 1 and 2 will be published when the review processes are completed and clearances received. Data from the third portion of the study were included in the "Report of Animal Investigation Program Activities for the Baneberry Event - December 18, 1970", which will be published in the near future.

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APPENDIX I. Acquisition Data and Vital Statistics of Mature Dairy Animals
1 January 1969 - 31 December 1970

Cow No.	Date of Birth Age as of 31 Dec 70	Weight Type of Breeding	Cost and Acquisition Date	Remarks
2	Nov 1958* 12 yrs 2 mos	1165 lbs Grade cow	\$225 Spring 1964 Dispersal sale Idaho	In herd. Severely lame.
11	Mar 1960* 10 yrs 9 mos	1305 lbs Grade cow	\$225 Spring 1964 Dispersal sale Idaho	In herd. Three- quartered and pen- dulous udder.
12	Mar 1960* 9 yrs 5 mos	1680 lbs Grade cow	\$225 Spring 1964 Dispersal sale Idaho	Three-quartered cow. Sacrificed for Project End- point. 28 Aug 1969.
13	Oct 1960* 10 yrs 3 mos	1395 lbs Grade cow	\$225 Spring 1964 Dispersal sale	In herd.
16	Nov 1958* 12 yrs 2 mos	1480 lbs Grade cow	\$225 Spring 1964 Dispersal sale Idaho	In herd.
18	Nov 1958* 12 yrs 2 mos	1470 lbs Grade cow	\$225 16 Aug 1964 U of Nev	Pendulous udder. Sacrificed 16 Dec 69. Wolf II.
19	14 Apr 1956	1395 lbs Grade cow	\$225 16 Aug 1964	Old cow with pendulous udder. Sacrificed 6 May 1970 Project Beryl.
21	26 Mar 1962 8 yrs 10 mos	1345 lbs Grade cow	\$225 16 Aug 1964 U of Nev	In herd.
26	24 Feb 1960 10 yrs 11 mos	1678 lbs Registered cow	\$400 Oats Bros. 15 Nov 1964	In herd.

APPENDIX I. Acquisition Data and Vital Statistics of Mature Dairy Animals
1 January 1969 - 31 December 1970 cont'd.

Cow No.	Age as of 31 Dec 70	Date of Birth	Weight Type of Breeding	Cost and Acquisition Date	Remarks
27	8 yrs 10 mos	8 Dec 1961	1650 lbs Registered cow	\$400 Cantlon Farms 15 Nov 1964	Snastic syndrome. Sacrificed 1 Oct 1969. Project Thallus.
35	4 yrs 11 mos	15 Jan 1965	1535 lbs Grade cow	Born in herd. Dam was No. 18. Sire - U of Nev bull.	Cystic ovaries and nymphomania. Sacrificed 14 Nov 1969. Project Wolf II.
36	5 yrs 9 mos	30 Dec 1964	1167 lbs Grade cow	Born in herd. Dam was No. 20. Sire - U of Nev bull.	Died 4 Sept 1970. Tympanites.
39	5 yrs 8 mos	13 Apr 1965	1555 lbs Registered cow	Born in herd. Dam was No. 28 Sire - Oats bull.	In herd.
43	8 yrs 3 mos	31 Oct 1962	1715 lbs Registered cow	\$450 Cantlon Farms 23 Jul 1965	To be culled from herd. Uterine infection.
44	11 yrs 5 mos	8 Nov 1959	1940 lbs Registered cow	\$450 Oats Bros. 23 Jul 1965	Bovine lymphosarcoma. Sacrificed 14 Jan 1970. Project RIMS.
45	10 yrs 9 mos	14 Apr 1960	1325 lbs Registered cow	\$500 Oats Bros. 23 Jul 1965	In herd.
46	10 yrs 4 mos	20 Sep 1960	1275 lbs Registered cow	\$500 Oats Bros. 23 Jul 1965	In herd.
47	12 yrs 8 mos	17 Apr 1958	1470 lbs Registered cow	\$400 Oats Bros. 23 Jul 1965	To be culled from herd. Poor producer.
48	8 yrs 10 mos	7 Mar 1962	1565 lbs Registered cow	\$400 Oats Bros. 23 Jul 1965	In herd.

APPENDIX I. Acquisition Data and Vital Statistics of Mature Dairy Animals
1 January 1969 - 31 December 1970 cont'd.

Cow No.	Date of Birth Age as of 31 Dec 70	Weight Type of Breeding	Cost and Acquisition Date	Remarks
62	16 Feb 1966 4 yrs 11 mos	1050 lbs Registered cow	Born in herd. Dam was No. 43 Sire - U of Nev bull	Coliform Mastitis. Sacrificed 13 Aug 1970. Project Quicksilver.
70	2 Apr 1966 3 yrs 6 mos	2500 lbs Registered bull	Born in herd. Dam was No. 47 Sire - Oats Bull	Used as herd sire until became too dangerous - sacrificed for AIP. 16 Oct 1969.
71	3 Apr 1966 4 yrs 10 mos	1470 lbs Registered cow	Born in herd. Dam was No. 48. Sire - Cantlon's Phantom	In herd.
83	19 Jun 1962 8 yrs 6 mos	1385 lbs Registered cow	\$499 Oats Bros. 16 Nov 1966	In herd.
84	16 Sep 1960 10 yrs 4 mos	1345 lbs Registered cow	\$450 Oats Bros. 16 Nov 1966	In herd.
85	28 Nov 1960 9 yrs 11 mos	1554 lbs Registered cow	\$500 Oats Bros. 16 Nov 1966	Arthritic cow. Sacrificed 19 Aug 1970. Project Quicksilver.
86	25 Jan 1962 8 yrs 11 mos	1175 lbs Registered cow.	\$450 Oats Bros 16 Nov 1966	Pendulous udder. Sacrificed 28 Aug 1969. Project Endpoint.
87	27 Jul 1962 8 yrs 5 mos	1515 lbs Registered cow	\$600 Oats Bros. 16 Nov 1966	In herd.
90	16 Jan 1967 3 yrs 6 mos.	1430 lbs Registered cow	Born in herd. Dam was No. 25. Sire - H-46	Mastitis cow. Sacrificed 30 Jun 1970. Project Rubi.
92	12 Feb 1967 2 yrs 9 mos	1280 lbs Registered cow	Born in herd. Dam was No. 28 Sire H-46.	Intractable temperment. Sacrificed 28 Aug 1969. Project Endpoint
116	29 Nov 1967 3 yrs 1 mo	1255 lbs Grade cow	Born in herd. Dam was No. 11 Sire No. 70.	In herd. Completed first lactation.

APPENDIX I. Acquisition Data and Vital Statistics of Mature Dairy Animals
1 January 1969 - 31 December 1970 cont'd.

Cow No.	Age	Date of Birth as of 31 Dec 70	Weight Type of Breeding	Cost and Acquisition Date	Remarks
117		30 Nov 1967 3 yrs 1 mo	1600 lbs Registered	Born in herd. Dam was No. 83	In herd. To be culled. Poor producer and barren.
119		23 Dec 1967 3 yrs	1535 lbs Registered cow	Born in herd. Dam was No. 83 Sire H-37	In herd. In first lactation.
122		16 Feb 1968 2 yrs 10 mos	1399 lbs Grade cow	Born in herd. Dam was No. 2 Sire No. 70	In herd. In first lactation.
123		21 Feb 1968 2 yrs 10 mos	1310 lbs Grade cow	Born in herd. Dam was No. 35 Sire No. 70	In herd. In first lactation.
126		15 Apr 1968 2 yrs 8 mos	1850 lbs Grade bull	Born in herd. Dam was No. 16 Sire No. 70	In herd. Served as herd sire since Oct 1969.
127		24 Apr 1968 2 yrs 8 mos	1280 lbs Registered cow	Born in herd. Dam was No. 62 Sire No. 70	In herd. In first lactation.
128		16 May 1968 2 yrs 7 mos	1410 lbs Registered cow	Born in herd. Dam was No. 39 Sire No. 70	In herd. In first lactation.
132		1 Jul 1968 2 yrs 6 mos	1245 lbs Registered heifer	Born in herd. Dam was No. 47 Sire No. 70	In herd. In first gestation.
133		19 Jul 1968 2 yrs 5 mos	1500 lbs Grade heifer	Born in herd. Dam was No. 13 Sire No. 70	In herd. In first gestation.
134		25 Jul 1968 2 yrs 5 mos	1475 lbs Registered heifer	Born in herd. Dam was No. 27 Sire No. 70	In herd. In first gestation.
135		7 Aug 1968 2 yrs 4 mos	1495 lbs Registered heifer	Born in herd. Dam was No. 43 Sire No. 70	In herd. In first gestation.

APPENDIX I. Acquisition Data and Vital Statistics of Mature Dairy Animals
1 January 1969 - 31 December 1970 cont'd.

Cow No.	Age	Date of Birth as of 31 Dec 70	Weight Type of Breeding	Cost and Acquisition Date	Remarks
139		21 Aug 1968 2 yrs 4 mos	1100 lbs Grade heifer	Born in herd. Dam was No. 21 Sire No. 70	In herd. In first gestation.
171		1 Jul 1966 4 yrs 5 mos	960 lbs Registered Jersey cow	\$450 6 Nov 1969 Mills Jersey Farm. Fallon, Nevada.	In herd.
172		5 May 1965 5 yrs 7 mos	880 lbs Registered Jersey cow	\$450 6 Nov 1969 Mills Jersey Farm. Fallon, Nevada.	In herd. To be culled. Pendulous udder.
173		13 Jul 1965 5 yrs 5 mos	945 lbs Registered Jersey cow	\$450 6 Nov 1969 Mills Jersey Farm. Fallon, Nevada.	In herd.
174		8 Aug 1965 5 yrs 4 mos	955 lbs Registered Jersey cow	\$450 6 Nov 1969 Mills Jersey Farm. Fallon, Nevada	In herd.
175		6 Jul 1966 4yrs 5 mos	1050 lbs Registered Jersey cow	\$300 6 Nov 1969 Mills Jersey Farm. Fallon, Nevada	In herd.

*Estimated date of birth, as no records prior to purchase.

APPENDIX II. Production and Reproduction of Cows - 1 January 1969 - 31 December 1970

Cow No.	Lactation No.	Period & Length of Lactation	Days Dry Preceding Lactation	Open Days	No. & Type of Breeding	Days Carried Calf	Pounds Milk Production	Average Butterfat %	Remarks
2	8*	3/18/69 12/21/69 278 days	113	62	1 A.I.**	216	13,918	3.4	
	9*	2/16/70 11/24/70 281 days	57	250	4 A.I.	31	15,046	3.8	
11	6*	11/22/68 8/15/69 256 days	79	49	1 A.I.	217	16,353	4.2	
	7*	10/21/69 8/29/70 312 days	56	115	1 A.I.	197	15,303	3.0	
12	7*	12/9/68 8/28/69 262 days	96	107	1 A.I.	155	12,167	3.3	Sacrificed 28 Aug 1969. Project Endpoint. Cow selected because of atrophied quarter.
13	6*	7/19/68 5/31/69 316 days	63	177	2 A.I. 1 Bull	139	15,109	3.4	
	7*	10/25/69 7/22/70 270 days	147	67	1 A.I.	203	15,300	4.3	

APPENDIX II. Production and Reproduction of Cows - 1 January 1969 - 31 December 1970 cont'd.

Cow No.	Lactation No.	Period & Length of Lactation	Days Dry Preceding Lactation	Open Days	No. & Type of Breeding	Days Carried Calf	Pounds Milk Production	Average Butterfat %	Remarks
16	7*	4/15/68 1/1/69 260 days	68	55	1 Bull	205	17,368	3.6	
	8*	3/16/69 1/1/70 291 days	75	74	1 A.I. 1 Bull	217	13,918	3.5	
18	8*	2/7/69 12/16/69 312 days	174	312	5 A.I. 2 Bull	0	18,204	4.5	Cow sacrificed 16 Dec 69. Project Wolf II. Cow selected because of breeding problems and pendulous udder.
19	10	1/3/69 10/20/69 290 days	220	155	3 A.I. 1 Bull	135	13,564	4.4	
	11	3/10/69 5/6/69 57 days	141				2,775	3.5	Cow gave birth to twins. She was sacrificed 6 May 70 for Project Beryl, so lactation was incomplete. Cow selected for sacrifice because of age, breeding history, and udder condition.
21	5	8/16/68 5/25/69 282 days	91	54	1 Bull	228	19,302	4.3	

APPENDIX II. Production and Renroduction of Cows - 1 January 1969 - 31 December 1970 cont'd.

No.	Lactation No.	Period & Length of Lactation	Days Dry Preceding Lactation	Open Days	No. & Type of Breeding	Days Carried Calf	Pounds Milk Production	Average Butterfat %	Remarks
	6	7/16/69 6/3/70 322 days	52	244	4 A.I. 2 Bulls	72	17,437	4.0	
26	6	11/29/68 8/15/69 259 days	227	94	1 A.I.	165	12,563	3.9	Seriously ill with intussusception during January 1969.
	7	12/9/69 8/29/70 263 days	116	110	1 Bull	153	13,591	3.7	
27	5	7/25/68 6/6/69 316 days	110	106	2 A.I.	210	19,458	3.8	
	6	8/18/69 10/1/69 45 days	73				1,831	3.4	Lactation incomplete as cow sacrificed 1 Oct 69 for Project Thallus. Cow selected for sacrifice as had spastic syndrome which made her unsuitable for metabolism studies.
35	2	2/21/68 1/1/69 315 days	74	316	Multiple breedings	0	16,131	3.7	Cow developed cystic ovaries and was non-responsive to treatment. Became nymphomaniac and remained barren for rest of life. Sacrificed 14 Nov 69 for Project Wolf II.

APPENDIX II. Production and Reproduction of Cows - 1 January 1969 - 31 December 1970 cont'd.

Cow No.	Lactation No.	Period & Length of Lactation	Days Dry Preceding Lactation	Open Days	No. & Type Breeding	Days Carried Calf	Pounds Milk Production	Average Butterfat %	Remarks
38	36	2 4/1/68 1/1/69 275 days	103	56	1 Bull	219	12,358	3.3	
		3 2/23/69 11/19/69 269 days	54	105	1 A.I.	164	12,424	3.5	Cow had twins.
		4 3/8/70 9/4/70 185 days	104				11,019	3.4	Lactation not complete as the cow died of tympanities 4 Sep 70.
	39	2 5/16/68 7/4/69 414 days	148	67 days 1st breeding 52 days 2nd breeding	2 Bull breeding	155 days breeding 140 days 2nd breeding	1st 18,321	3.8	Extra long lactation period because cow aborted a 5-month old fetus on 24 Dec 68. She was rebred on 14 Feb and conceived.
		3 11/19/69 10/20/70 325 days	138	112	2 A.I.	213	17,569	4.0	
	43	4 8/7/68 1/16/69 162 days	37	69	1 Bull	93	6,782	3.9	Severely ill with mastitis in Aug 68, which caused permanent damage to the udder. Lactation ended early because of poor production.

APPENDIX II. Production and Reproduction of Cows - 1 January 1969 - 31 December 1970 cont'd.

Cow No.	Lactation No.	Period & Length of Lactation	Days Dry Preceding Lactation	Open Days	No. & Type Breeding	Days Carried Calf	Pounds Milk Production	Average Butterfat %	Remarks
	5	7/21/69 3/14/70 225 days	186	239	Multiple Breedings	0	9,515	4.0	Twin calves born. Cow developed pyometra which was not refractive too treatment. Despite many breedings, remained barren. To be culled from herd.
44	7	10/14/68 7/16/69 275 days	150	105	2 Bull	170	12,529	3.6	
39	8	11/6/69 1/14/70 69 days	113				3,459	3.7	Lactation incomplete as cow in terminal phase of bovine lymphosarcoma, so on 14 Jan 70, she was euthanized and utilized for Project RIMS.
45	7	4/15/69 11/21/69 220 days	126	178	2 A.I.	42	9,702	4.0	Cow had severe mastitis in July and Aug 69. One quarter lost its milk secretory ability.
46	6	9/6/68 6/6/69 273 days	153	54	1 Bull	219	14,941	4.2	
	7	7/29/69 4/6/70 251 days	53	124	2 A.I.	127	10,407	4.0	

APPENDIX II. Production and Reproduction of Cows - 1 January 1969 - 31 December 1970 cont'd.

Cow No.	Lactation No.	Period & Length of Lactation	Days Dry Preceding Lactation	Open Days	No. & Type Breeding	Days Carried Calf	Pounds Milk Production	Average Butterfat %	Remarks
47	8	7/1/68 4/18/69 291 days	157	135	2 Bull	156	12,165	3.6	
	9	8/12/69 3/14/70 217 days	116	113	2 A.I.	101	8,786	3.9	To be culled from herd as a poor producer and is an aged cow.
48	5	11/25/68	158	128	1 Bull				No production data as cow used as nurse cow.
	6	1/11/70 9/23/70 255 days		123	2 A.I.	132	11,345	3.8	
62	1	4/24/68 2/5/69 287 days		32	1 Bull	235	12,146	3.8	
	2	3/25/69 1/1/70 282 days	48	80	1 A.I.	202	13,178	3.7	
	3	3/18/70 8/13/70 148 days	76	130	2 A.I. 1 Bull	18	8,926	3.9	Lactation incomplete as the cow developed coliform mastitis while in metabolism stall for Project Quicksilver Salvaged for this project as a sacrifice animal on 13 Aug 70.

APPENDIX II. Production and Reproduction of Cows - 1 January 1969 - 31 December 1970 cont'd.

Cow No.	Lactation No.	Period & Length of Lactation	Days Dry Preceding Lactation	Open Days	No. & Type of Breeding	Days Carried Calf	Pounds Milk Production	Average Butterfat %	Remarks
71	2	2/25/69 1/1/70 310 days	192	88	1 A.I. 1 Bull	222	11,065	4.4	
	3	3/3/70 9/23/70 204 days	61	140	2 A.I.	62	8,815	3.5	Cow suffered from chronic mastitis during this lactation.
83	4	10/20/68 8/1/69 285 days	64	134	1 Bull 2 A.I.	151	13,683	3.6	Twin calves.
	5	12/18/69 9/23/70	139	48 33	1 A.I. 1 A.I.	150 28	16,779	3.9	Cow aborted 24 Jul 70 - two sets of figures for open days and days carried calves.
84	6	8/14/68 4/22/69 251 days	89	53	1 Bull	198	11,065	3.5	Twin calves.
	7	7/16/69 2/20/70 219 days	85	72	1 A.I. 1 Bull	147	7,866	3.2	
85	6	2/24/69 11/21/69 270 days	124	57	1 A.I.	213	14,428	3.9	
	7	1/16/70 8/19/70 215 days	56	72	1 Bull	143	12,279	4.1	Lactation record incomplete as cow was sacrificed 19 Aug 70 for Project Quick-silver. Cow was selected for

APPENDIX II. Production and Reproduction of Cows 1 January 1969 - 31 December 1970 cont'd.

Cow No.	Lactation No.	Period & Length of lactation	Days Dry Preceding Lactation	Open Days	No. & Type of Breeding	Days Carried Calf	Pounds Milk Production	Average Butterfat %	Remarks
									sacrifice because of lameness associated with arthritis.
86	5	8/7/68 3/27/69 232 days	123	74	1 A.I.	159	5,529	3.9	Lactation record incomplete as cow served as nurse cow from 7 Aug-25 Nov 68.
	6	7/21/69 8/28/69 38 days	116	38		0	1,806	3.5	Lactation record incomplete as cow was sacrificed 28 Aug 69 for Project Endpoint. Cow was selected because of pendulous udder.
87	5	6/25/69 5/9/70 318 days	215	194	1 Bull	124	17,981	4.2	
90	1	6/10/69 3/24/60 287 days		74	1 A.I.	213	10,698	4.1	
	2	5/31/70 6/30/70 30 days	68	30		0	576	4.0	Lactation record incomplete as cow sacrificed for Project Rubi on 30 June 70. Cow selected as had coliform mastitis upon freshening.

APPENDIX II. Production and Reproduction of Cows 1 January 1969 - 31 December 1970 cont'd.

Cow No.	Lactation No.	Period & Length of Lactation	Days Dry Preceding Lactation	Open Days	No. & Type of Breeding	Days Carried Calf	Pounds Milk Production	Average Butterfat %	Remarks
92	1	6/14/69 8/28/69 75 days		74		0	1,121	4.1	Lactation record incomplete as cow sacrificed for Project Endpoint on 28 Aug 69. Cow selected because of intractable temperment and poor production.
116	1	2/8/70 10/31/70 265 days		54	1 Bull	211	14,125	3.8	Good replacement cow.
117	1	2/11/70 2/28/70 17 days					151		Lactation terminated as cow would not produce and was intractable. Will be culled from herd.
171	2	6/17/69 3/6/70 262 days	60	62	1 A.I.	200	8,599	4.9	Purchased 6 Nov 69. Production record combination of DHIA records and actual production
172	3	8/14/69 4/3/70 231 days	60	97	1 A.I.	135	7,230	4.9	Purchased 6 Nov 69. Production record combination of DHIA** records and actual production. Cow was poor producer and has pendulous udder. Will be culled from herd.

APPENDIX II. Production and Reproduction of Cows 1 January 1969 - 31 December 1970 cont'd.

Cow No.	Lactation No.	Period & Length of Lactation	Days Dry Preceding Lactation	Open Days	No. & Type of Breeding	Days Carried Calf	Pounds Milk Production	Average Butterfat %	Remarks
173	3	9/17/69 6/30/70 286 days	60	72	1 A.I.	214	9,994	4.8	Purchased 6 Nov 69. Production record was combination of DHIA records and actual production.
174	3	9/22/69 4/03/70 193 days	60	100	3 A.I.	93	8,644	5.4	Purchased 6 Nov 69. Production record was combination of DHIA records and actual production.
175	2	6/08/69 6/01/70 358 days	60	342	3 A.I. 2 Bull	16	11,036	4.4	Purchased 6 Nov 69. Production record was combination of DHIA records and actual production.

APPENDIX II. Production and Reproduction of Cows 1 January 1969 - 31 December 1970 cont'd.

	Average Lactation Period and Length of Cows in Herd 12/31/70	of all Complete Lactations	Days Dry Preceding Lactation	Open Days	Breedings	Days Carried Calf	Pounds Milk Production all Complete Lactations	Average Butterfat %	Remarks
Summary of herd average data	5.2	277 days	108	110	1.9	178	13,333	3.9	Average age of lactating cows as of 31 Dec 70 was 7 yrs 10 mos

*Estimated, as no records prior to purchase
 **A.I. = Artificial Insemination
 ***DHIA = Dairy Herd Improvement Association

APPENDIX III. Calves Born into Herd 1 January 1969 - 31 December 1970

Animal No.	Date of Birth Sex Wt. at Birth	Dam & Sire	Type of Breeding	Remarks
148	3 Jan 1969 Male 70 lbs.	No. 19 & 70	Holstein	Euthanized 3 January 1969. No use in program.
149	7 Feb 1969 Male 70 lbs.	No. 18 & 70	Holstein	Euthanized 7 Feb 1969. No use in program.
150*	23 Feb 1969 Male 70 lbs.	No. 36 & 70	Holstein	Euthanized 23 Feb 1969. No use in program.
151*	23 Feb 1969 Female 65 lbs.	No. 36 & 70	Holstein	Dead when found.
152	24 Feb 1969 Male 70 lbs.	No. 85 & 70	Holstein	Euthanized 24 Feb 1969. No use in program.
153	25 Feb 1969 Female 85 lbs.	No. 153 & 70	Holstein	In herd. Saved for replace- ment.
154	16 Mar 1969 Male Unknown	No. 16 & 70	Holstein	Sacrificed 25 Nov 1969 for Project Wolf II. Fed milk from cow No. 87.
155	18 Mar 1969 Male Unknown	No. 2 & 70	Holstein	Euthanized 19 Mar 1969. No use in program.
156	25 Mar 1969 Male Unknown	No. 62 & 70	Holstein	Euthanized 25 Mar 1969. No use in program.
157	15 Apr 1969 Male 100 lbs.	No. 45 & 70	Holstein	Euthanized 15 Apr 1969. No use in program.
158	10 Jun 1969 Male Unknown	No. 90 & 70	Holstein	Euthanized 11 Jun No use in program.

APPENDIX III. Calves Born into Herd 1 January 1969 - 31 December 1970 cont'd.

Animal No.	Date of Birth Sex Wt. at Birth	Dam & Sire	Type of Breeding	Remarks
159	14 Jun 1969 Female Unknown	No. 92 & 70	Holstein	In herd. Saved for replacement.
160	25 Jun 1969 Male Unknown	No. 87 & 70	Holstein	Euthanized 25 Jun 1969. No use in program.
161	16 Jul 1969 Male Unknown	No. 84 & 70	Holstein	Euthanized 16 Jul 1969. No use in program.
162	16 Jul 1969 Female Unknown	No. 21 & 70	Holstein	In herd. Saved for replacement.
163*	21 Jul 1969 Male Unknown	No. 43 & 70	Holstein	Euthanized 21 Jul 1969. No use in program.
164*	21 Jul 1969 Male Unknown	No. 43 & 70	Holstein	Euthanized 21 Jul 1969. No use in program.
165	21 Jul 1969 Male Unknown	No. 86 & H-245	Holstein	Euthanized 21 Jul 1969. No use in program.
166	29 Jul 1969 Male Unknown	No. 46 & 70	Holstein	Euthanized 29 Jul 1969. No use in program.
167	12 Aug 1969 Male Unknown	No. 47 & 70	Holstein	Euthanized 12 Aug 1969 No use in program.
168	18 Aug 1969 Male Unknown	No. 27 & H-245	Holstein	Euthanized 18 Aug 1969. No use in program.
169	21 Oct 1969 Male 90 lbs.	No. 11 & H-28	Holstein	Sacrificed 3 Nov 1969 for Project Wolf II. Fed milk from cows Nos. 87 & 43.

APPENDIX III. Calves Born into Herd 1 January 1969 - 31 December 1970 cont'd.

Animal No.	Date of Birth Sex Wt. at Birth	Dam & Sire	Type of Breeding	Remarks
170	25 Oct 1969 Male 90 lbs.	No. 13 & H-28	Holstein	Sacrificed 20 Jan 1970. Project Thallus II.
176*	6 Nov 1969 Male Unknown	No. 44 & 70	Holstein	Dead at birth. Dystocia.
177*	6 Nov 1969 Female Unknown	No. 44 & 70	Holstein	Dead at birth. Dystocia.
178	19 Nov 1969 Male 87 lbs.	No. 39 & 70	Holstein	Sacrificed 29 Jan 1970. Thallus II. Fed milk from No. 39. Weighed 220 lbs.
179	9 Dec 1969 Female Unknown	No. 26 & H-245	Holstein	In herd. Saved for replace- ment.
180	18 Dec 1969 Male Unknown	No. 83 & H-245	Holstein	Dead at birth.
181	11 Jan 1970 Male 82 lbs.	No. 48 & 511	Hereford- Holstein	Crossbred calf. Sacrificed 1 May 1970 - Project Beryl.
182	16 Jan 1970 Male 64 lbs.	No. 85 & H-57	Holstein	Poor quality calf. Euthanized 19 Feb 1970.
183	8 Feb 1970 Male 84 lbs.	No. 116 & 70	Holstein	Sacrificed 6 May 1970. Project Beryl. Weighed 205 lbs.
184	11 Feb 1970 Female 85 lbs.	No. 117 & H-57	Holstein	In herd. Saved for replace- ment.
185	16 Feb 1970 Female 92 lbs.	No. 2 & H-306	Holstein	Sacrificed 19 Aug 1970. Project Quicksilver.

APPENDIX III. Calves Born into Herd 1 January 1969 - 31 December 1970 cont'd.

Animal No.	Date of Birth Sex Wt. at Birth	Dam & Sire	Type of Breeding	Remarks
186	3 Mar 1970 Male 88 lbs.	No. 71 & 126	Holstein	Sacrificed 18 May 1970. Project Beryl.
187	8 Mar 1970 Male 90 lbs.	No. 36 & H-306	Holstein	In herd. Saved for replace- ment bull.
188	9 Mar 1970 Male 90 lbs.	No. 16 & 70	Holstein	Dead at birth.
189*	10 Mar 1970 Male 75 lbs.	No. 19 & 70	Holstein	Sacrificed 18 Jun 1970. Project Rubi. Weighed 189 lbs.
190*	10 Mar 1970 Female 75 lbs.	No. 19 & 70	Holstein	Euthanized 29 Apr 1970. Pseudohermaphrodite.
191	18 Mar 1970 Male 92 lbs.	No. 62 & H-342	Holstein	Sacrificed 23 Jun 1970. Project Rubi. Weighed 304 lbs.
192	11 Apr 1970 Male 93 lbs.	No. 119 & H-344	Holstein	Sacrificed 29 Jun 1970. Project Rubi. Weighed 209 lbs.
193	16 May 1970 Female 78 lbs.	No. 123 & H-342	Holstein	Sacrificed 19 Aug 1970. Project Quicksilver.
194	26 May 1970 Female 60 lbs.	No. 171 & Mills Bull	Jersey	Sacrificed 9 Aug 1970. Project Quicksilver.
195	31 May 1970 Male 100 lbs.	No. 90 & H-50	Holstein	Sacrificed 9 Aug 1970. Project Quicksilver.
196	2 Jun 1970 Female 76 lbs.	No. 122 & 126	Holstein	In herd. Saved for replace- ment.

APPENDIX III. Calves Born into Herd 1 January 1969 - 31 December 1970 cont'd.

Animal No.	Date of Birth Sex Wt. at Birth	Dam & Sire	Type of Breeding	Remarks
197	1 Jul 1970 Female 83 lbs.	No. 127 & 126	Holstein	In herd. Replacement heifer.
198	1 Jul 1970 Female 90 lbs.	No. 45 & 126	Holstein	In herd. Replacement heifer.
199	4 Jul 1970 Male 91 lbs.	No. 84 & H-50	Holstein	Dead at birth.
No No.	24 Jul 1970 Male Not weighed	No. 83 & H-290	Holstein	No. 83 aborted a 5-month- old fetus after treatment for traumatic reticulitis.
No No.	20 Aug 1970 Unknown Unknown	No. 172 & A.I.	Jersey	Calf never found. Coyotes may have killed and eaten it.
200	2 Sep 1970 Male Not weighed	No. 46 & H-344	Holstein	Declared surplus. Trans- ferred to University of Nevada, Reno on 13 Nov 1970.
201	3 Sep 1970 Male Not weighed	No. 173 & J-4931	Jersey	Declared surplus. Trans- ferred to University of Nevada, Reno on 13 Nov 1970.
202	5 Sep 1970 Female Not weighed.	No. 47 & H-303	Holstein	Sacrificed 22 Dec 1970. Baneberry Event.
203	29 Sep 1970 Male Not weighed	No. 13 & H-344	Holstein	Declared surplus. Trans- ferred to University of Nevada, Reno on 13 Nov 1970.
204	13 Oct 1970 Male 63 lbs.	No. 174 & J-4931	Jersey	Declared surplus. Trans- ferred to University of Nevada, Reno on 13 Nov 1970.
205	14 Oct 1970 Female 93 lbs.	No. 87 & H-303	Holstein	Sacrificed 22 Dec 1970. Baneberry Event.

APPENDIX III. Calves Born into Herd 1 January 1969 - 31 December 1970 cont'd.

Animal No.	Date of Birth	Sex Wt. at Birth	Dam & Sire	Type of Breeding	Remarks
206	16 Nov 1970	Male 93 lbs.	No. 134 & H-290	Holstein	In herd.
207	20 Nov 1970	Male 96 lbs.	No. 11 & H-290	Holstein	In herd.
208	17 Dec 1970	Female	No. 39 & H-290	Holstein	In herd. Replacement heifer.
209	28 Dec 1970	Female	No. 21 & 126	Holstein	In herd. Replacement heifer.

*Indicates twins.

APPENDIX IV. Mastitis Incidence in Individual Cows (listed by date and quarter affected)

Cow No.	Jan-Mar 1969	Apr-Jun 1969	Jul-Sep 1969	Oct-Dec 1969	Jan-Mar 1970	Apr-Jun 1970	Jul-Sep 1970	Oct-Dec 1970
2							18-20 Sep L.R.*	
11		11-12 Jun R.F.**			19-21 Jan R.R.*** 21-22 Feb R.R.	2 Jun L.R.		
12	13-15 Feb R.F.							
13					19-21 Jan L.F.† 16-18 Feb R.R.			
16		13-15 Apr L.R. 19-21 Jun L.F.	23-26 Aug L.F.			3-5 Apr R.R.	25-31 Aug R.F. 18 Sep R.R., L.R.	
18								
19								
21			28-30 Jul R. R. 20-22 Aug L.R. 3-6 Sep R.R.	4-8 Oct R.R. 18 Nov L.R. 5-7 Dec R.R. 13-15 Dec L.R.	3 Jan L.R. 8-10 Jan R.R. 19-21 Jan R.R. 13-19 Feb R.R.	14-16 May R.R.		30 Dec L.F.
26			4-5 Aug L.R.				17-23 Jul L.R. 29 Jul L.R.	
27		1-2 Apr L.R.	20-27 Aug L.R., R.R.					

APPENDIX IV. Mastitis Incidence in Individual Cows (listed by date and quarter affected) cont'd.

Cow No.	Jan-Mar 1969	Apr-Jun 1969	Jul-Sep 1969	Oct-Dec 1969	Jan-Mar 1970	Apr-Jun 1970	Jul-Sep 1970	Oct-Dec 1970
35								
36		8-10 Apr L.R.						
39					29-30 Mar L.F.			20-21 Dec R.R.
43								
44		14-19 May L.R. 23-26 May L.R.			11-20 Nov R.F. Coliform mastitis R.F. quarter atrophied			
45			28 Jul-5 Aug R.R. Lost quarter				18-20 Jul R.F. 4 Sep L.F.	
46							18-21 Sep L.R.	
47								15 Dec R.F.
48					2-3 Mar L.R., R.R.		29-31 Jul R.F. 21-23 Sep L.F.	
62							11-13 Aug Coliform mastitis while on experiment. Sacrificed.	
71			10-11 Jul L.R.			22-24 May R.R. 30 Jun L.R.	8 Jul R.R. 22-23 Sep L.R.	

APPENDIX IV. Mastitis Incidence in Individual Cows (listed by date and quarter affected) cont'd.

Cow No.	Jan-Mar 1969	Apr-Jun 1969	Jul-Sep 1969	Oct-Dec 1969	Jan-Mar 1970	Apr-Jun 1970	Jul-Sep 1970	Oct-Dec 1970
83	25 Feb- 3 Mar R.R.				7-9 Mar R.R.		29-31 Jul R.R. 24-29 Aug L.F. 22 Sep R.R.	
84							8 Jul L.F.	
85		2-13 Jun R.F.	4-5 Aug R.R.					
86								
87						17-18 Apr L.R., L.F. 27-28 Apr. L.R., L.F.		20-21 Dec L.F. 27 Dec L.F.
90						2-13 Jun Severe udder edema and mastitis. Sacrificed		
92								
116								
117								
119								
122							15-19 Jul All	
123								
127							15-19 Jul All 21-22 Aug R.F.	
128								
171								

APPENDIX IV. Mastitis Incidence in Individual Cows (listed by date and quarter affected) cont'd.

Cow No.	Jan-Mar 1969	Apr-Jun 1969	Jul-Sep 1969	Oct-Dec 1969	Jan-Mar 1970	Apr-Jun 1970	Jul-Sep 1970	Oct-Dec 1970
172								
173								
174								
175								

*L.R. = left rear quarter
 **R.F. = right fore quarter
 ***R.R. = right rear quarter
 †L.F. = left fore quarter

APPENDIX V. List of Cows Arranged by Cow Number Showing Participation in Experiments

Cow No.	Shimoda 5/13/69	Wolf I 7/24/69	Plum 8/13/69	Endpoint 8/27/69	Thallus I 9/15/69	Wolf II 10/29/69	RIMS I 12/9/69	Lightwater I 12/22/69
2							Oral molecular ^{131}I .	
11							Oral inorganic iodide ^{131}I .	
12				Single I.V. ^{131}I . Terminal Study.				
13							Oral multiple iodide ^{131}I .	
16							Oral inorganic iodide ^{131}I .	
18						Multiple oral ^{181}W . Terminal Study.		
19								
21					Single oral ^{202}Tl .		Oral molecular ^{131}I .	Single oral ^3H .
26							Control	

APPENDIX V. List of Cows Arranged by Cow Number Showing Participation in Experiments cont'd.

Cow No.	Shimoda 5/13/69	Wolf I 7/24/69	Plum 8/13/69	Endpoint 8/27/69	Thallus I 9/15/69	Wolf II 10/29/69	RIMS I 12/9/69	Lightwater I 12/22/69
27					Single oral ^{202}Tl Terminal Study.			
35						Multiple oral ^{181}W . Terminal Study.		
36	Multiple dose Ingestion hay ^{131}I , ^{123}I , ^{124}I capsule	Single oral ^{187}W	Single oral ^{203}Pb					
39							Oral molecular ^{131}I	
43					Single oral ^{202}Tl .	Multiple oral ^{181}W .		
44							Oral iodate. ^{131}I . Terminal.	
45	Ingestion hay ^{131}I . Cap- sule ^{123}I , ^{124}I .	Single oral ^{187}W .						
46			Single oral ^{203}Pb				Oral inorganic iodide ^{131}I .	

APPENDIX V. List of Cows Arranged by Cow Number Showing Participation in Experiments cont'd.

Cow No.	Shimoda 5/13/69	Wolf I 7/24/69	Plum 8/13/69	Endpoint 8/27/69	Thallus I 9/15/69	Wolf II 10/29/69	RIMS I 12/9/69	Lightwater I 12/22/69
47					Single oral ^{202}Tl .	Multiple oral ^{181}W .	Oral iodate ^{131}I .	
48								
55								
62	Ingestion hay ^{131}I . Capsule ^{123}I , ^{124}I .	Single oral ^{187}W .	Single oral ^{203}Pb .				Oral iodate ^{131}I .	
71	Capsule ^{123}I , ^{124}I , ^{131}I .	Single oral ^{187}W .	Single oral ^{203}Pb .				Oral methyl- iodide ^{131}I .	
83								
84							Oral methyl iodide ^{131}I	
85								
86				Single oral ^{131}I . Terminal Study				

APPENDIX V. List of Cows Arranged by Cow Number Showing Participation in Experiments cont'd.

Cow No.	Shimoda 5/13/69	Wolf I 7/24/69	Plum 8/13/69	Endpoint 8/27/69	Thallus I 9/15/69	Wolf II 10/29/69	RIMS I 12/9/69	Lightwater I 12/22/69
87					Single oral ^{202}Tl .	Multiple oral ^{181}W .		
90							Oral iodate ^{131}I .	Single oral ^3H .
92				Single oral ^{131}I . Terminal Study.				
171							Oral molecular iodide ^{131}I	Single oral ^3H
172							Oral methyl iodide ^{131}I	
173							Control	
174							Oral inorganic ^{131}I	
175							Oral iodate ^{131}I	Single oral ^3H

APPENDIX V. List of Cows Arranged by Cow Number Showing Participation in Experiments cont'd.

Cow No.	Thallus II 1/09/70	Rims II 2/10/70	Wolf III 3/03/70	Beryl 4/27/70	Rubi 6/15/70	Quicksilver 8/03/70	Washout 9/29/70	Ferric 10/19/70	Baneberry 12/18/70
2			Single I.V. ^{187}W		Single oral ^{86}Rb				
11	Multiple oral ^{202}Tl								Inhalation and Ingestion study
13	Multiple oral ^{202}Tl			Single oral ^7Be				Single oral ^{59}Fe	Inhalation study
16					Single oral ^{86}Rb		Multiple in- gestion wash- out ^{131}I		Ingestion meta- bolism study
19				Single I.V. ^7Be Terminal study					
26			Single I.V. ^{187}W						
36				Single oral ^7Be		Single oral ^{103}Hg			
39	Multiple oral ^{202}Tl								
45							Multiple in- gestion ^{131}I dry		Ingestion meta- bolism study

APPENDIX V. List of Cows Arranged by Cow Number Showing Participation in Experiments cont'd.

Cow No.	Thallus II 1/09/70	Rims II 2/10/70	Wolf III 3/03/70	Beryl 4/22/70	Rubi 6/15/70	Quicksilver 8/03/70	Washout 9/29/70	Ferric 10/19/70	Baneberry 12/18/70
46	Multiple oral 202 _{Tl}							Single oral 59 _{Fe}	Ingestion Study
48				Single oral 7 _{Be}					
62						Single oral 203 _{Hg} Terminal			
83			Single I.V. 187 _W	Single oral 7 _{Be}					
84							Multiple in- gestion wash- out 131I		
85						Single I.V. 203 _{Hg} Terminal			
87									Inhalation study
90					Single I.V. 86 _{Rb} Terminal				
116			Single I.V. 187 _W				Multiple in- gestion 131I dry		

APPENDIX V. List of Cows Arranged by Cow Number Showing Participation in Experiments cont'd.

Cow No.	Thallus II 1/09/70	Rims II 2/10/70	Wolf III 3/03/70	Beryl 4/22/70	Rubi 6/15/70	Quicksilver 8/03/70	Washout 9/29/70	Ferric 10/19/70	Baneberry 12/18/70
119					Single oral ^{86}Rb				Inhalation and ingestion study
122						Single oral ^{203}Hg	Multiple in- gestion dry ^{131}I	Single oral ^{59}Fe	
123					Single oral ^{86}Rb				Ingestion study
127						Single oral ^{203}Hg	Multiple in- gestion wash- out ^{131}I	Single oral ^{59}Fe	Inhalation study
134									Inhalation study
171		Oral $^{131}\text{I}_2$						Single I.V. ^{59}Fe	
172		Oral Na ^{131}I							
173		Oral Na ^{131}I							
174		Oral $^{131}\text{I}_2$							
175		Oral $^{131}\text{I}_2$							

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