



Summary of Studies Supporting USDA Product Licensure

Establishment Name	Intervet Inc.
USDA Vet Biologics Establishment Number	165A
Product Code	11C8.20
True Name	Bovine Rhinotracheitis-Parainfluenza 3-Respiratory Syncytial Virus-Mannheimia Haemolytica-Pasteurella Multocida Vaccine, Modified Live Virus, Avirulent Live Culture
Tradename(s) / Distributor or Subsidiary (if different from manufacturer)	Bovilis Nasalgen 3-PMH - Merck Animal Health Bovilis Nasalgen 3-PMH - No distributor specified
Date of Compilation Summary	October 28, 2020

Disclaimer: Do not use the following studies to compare one product to another. Slight differences in study design and execution can render the comparisons meaningless.

Study Type	Efficacy																		
Pertaining to	Infectious bovine rhinotracheitis (IBR)																		
Study Purpose	Demonstrate Duration of Immunity (effectiveness) of the infectious bovine rhinotracheitis (IBR) fraction against respiratory disease caused by IBR																		
Product Administration	One dose administered intranasally																		
Study Animals	Forty-six colostrum deprived calves, less than 1 week of age, divided into two groups: 21 vaccinates and 20 controls																		
Challenge Description	Challenged intranasally with virulent Cooper strain of IBR 195 days after vaccination																		
Interval observed after challenge	Calves observed daily for 16 days after challenge																		
Results	<p>Animals were considered affected by the challenge if they moderate to severe (severity score of 2) clinical signs (nasal or ocular discharge, nasal lesions, dyspnea, depression, anorexia, and/or cough) on any day during the post-challenge period, or a rectal temperature $\geq 104.0^{\circ}\text{F}$ for two or more consecutive days post-challenge. Nasal virus shedding was evaluated.</p> <p>For fever, an affected calf was one with a rectal temperature $\geq 104.0^{\circ}\text{F}$ for two or more consecutive post-challenge days.</p> <p>Totals: Affected: 9/21 vaccinates with IBR Morbidity 20/20 controls with IBR Morbidity</p> <p>Fever: 9/21 vaccinates 20/20 controls</p> <p>Duration of Nasal Shedding</p> <table border="1"> <thead> <tr> <th>Treatment</th> <th>Min.</th> <th>1st Qu.</th> <th>Median</th> <th>3rd Qu.</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Control</td> <td>6</td> <td>6</td> <td>7</td> <td>8</td> <td>10</td> </tr> <tr> <td>Vaccinate</td> <td>8</td> <td>9</td> <td>10</td> <td>10</td> <td>12</td> </tr> </tbody> </table> <p>Raw data: See attached.</p>	Treatment	Min.	1 st Qu.	Median	3 rd Qu.	Max	Control	6	6	7	8	10	Vaccinate	8	9	10	10	12
Treatment	Min.	1 st Qu.	Median	3 rd Qu.	Max														
Control	6	6	7	8	10														
Vaccinate	8	9	10	10	12														
USDA Approval Date	September 9, 2019																		

TABLE 1: Clinical Observations

Group	Calf ID	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Affected ¹	Duration ¹	Duration w/Fever ²	
Controls	2	0	0	0	0	0	0	N1,L1,R1	N2,L1,R1	N2,L1,R2	N2,L1,R1	N2,L1,R1	L2	0	0	0	0	0	0	Yes	5	8	
	4	0	0	0	0	0	0	N1,R1	N1,L1	N2,L2,R2	N1,L1	N1,L2	N1	0	0	0	0	0	0	Yes	3	6	
	7	0	0	0	0	0	0	N2,L2,R1	N2,L2,R1	N2,L2,R2	N2,L2,R2	N2,L2,R2	N2,L2,R2	N2,L2,R2	N2,L2,R1	L2	N2,L2	L2	L2	0	Yes	11	12
	9	0 ¹	0	0	0	0	0	N1,L1,R1	N2,L1,R2	N2,O1,L1,R2	N2,O1,L2,R2	N2,L2,R2	N2,L2,R2	N2,L2,R1	N2,L2,R1	N2,L2	L2	L2	0	Yes	10	13	
	10	0	0	0	0	0	0	N1	L1	N2,L1	N2,L1	N2,L2	N2,L2	N2,L2	N1,L2	L2	L2	0	0	Yes	8	12	
	12	0	0	0	0	0	0 ¹	N1,R1	N1,L1	N1,L1,R1	N2,L1,R1	N2,L1,R1	0	0	0	0	0	0	0	0	Yes	1	7
	13	0	0	0	0	0	0	0	L1	N1,L1	N2,L2,R2	N1,L1	0	0	0	0	0	0	0	0	Yes	1	6
	17	0	0	0	0	0	0	N2,L1,R1	N2,L2,R1	N2,L1,R1	N2,L1,R2	N2,L2,R2	N2,L1	N2	0	0	0	0	0	0	Yes	7	8
	19	0	0	0	0	0	0	N1	N2,L1	N1,L1	N2,L1,R2	0	0	0	0	0	0	0	0	0	Yes	3	5
	20	0	0	0	0	0	0	N1,L1	N1,L1	N2,L2,R1	N2,L2,R2	N2,L2,R2	L2	L2	0	0	0	0	0	0	Yes	5	9
	21	0	0	0	0	0	0	N2,R1	N2,L2,R1	N2,L2,R2	N2,O1,L1,R2	N2,O2,L2,R2	N2,O2,R2	N2,O2,L2,R	0	N1	0	0	0	0	Yes	7	10
	27	0	0	0	0	0	0	N2,L1,R1	N2,L1,R1	N2,L2,R2	N2,L2,R2	N2,L2,R2	N2,L2,R2	0	L2	L2	0	0	0	0	Yes	9	11
	28	0	0	0	0	0	0	N2,L2,R1	N2,L1	N2,L2,R2	N2,L2,R2	N2,L2,R2	0	0	0	0	0	0	0	0	Yes	5	7
	32	0	0	0	0	0	0	0	N2,D1,R1	N2,L1,R2	N2,L2,R2	N2,L2,R2	0	0	0	0	0	0	0	0	Yes	3	6
	37	0	0	0	0	0	0	N2,L2,R1	N2,L2,R1	N2,L2,R2	N2,L2,R2	N2,L2,R2	L2	L2	0	L2	0	0	0	0	Yes	9	10
	38	0	0	0	0	0	0	N2,L1,R1	N2,L1,R1	N2,L1,R2	N2,L1,R2	N2,L1,R2	N1,O1,R1	N1	0	0	0	0	0	0	Yes	5	7
	39	0	0	0	0	0	0	N1	0	N2,L1	N2,L2,R2	N2,L2,R2	N2,L2,R2	N2,L2	N2,L2	N1,L2	N2,L2	N2,L2	0	0	Yes	9	11
	42	0	0	0	0	0	0	N1	N1	N1,L1,R2	N1	N2,L1,R2	N1	N1	0	0	0	0	0	0	Yes	3	9
	45	0	0	0	0	0	0	L1	N1,D1	L1	N1,L1	N1,L1	N2,R1	N1	0	0	0	0	0	0	Yes	1	6
	46	0	0	0	0	0	0	0	N2,L1,R2	N2,L2,D1,R2	N2,L2,D1,R2	N2,O1,D1,R2	N2,L2,R2	N2,L2,R2	N2,R2	N2,L2,R2	N2	0	0	0	Yes	9	11
Vaccinates	1	0	0	0	0	0	0	N1,L1	N1,L1	N1,L1	N2,L2,R2	N1,L1,R1	0	0	0	0	0	0	0	Yes	1	4	
	3	0	0	0	0	0	0	N1	0	0	N1	N2,L2,R1	0	0	0	0	0	0	0	Yes	1	7	
	5	0	0	0	0	0	0	N1,R1	L1	0	N2,L1,R1	N1,L1	0	0	0	0	0	0	0	Yes	1	5	
	6	0	0	0	0	0	0	R1	N1	0	0	N1	0	0	0	0	0	0	0	No	0	0	
	8	0	0	0	0	0	0	0	0	O1	0	0	0	0	0	0	0	0	0	0	No	0	0
	11	0	0	0	0	0	0	0	0	0	N1	0	0	0	0	0	0	0	0	0	No	0	8
	14	0	0	0	0	0	0	0	0	N1,L1	0	0	0	0	0	0	0	0	0	0	No	0	0
	15	0	0	0	0	0	0	N1	N2,L1	0	0	N1	0	0	0	0	0	0	0	0	Yes	1	10
	16	0	0	0	0	0	0	N1,R1	N1	N1	N1	0	0	0	0	0	0	0	0	0	No	0	2
	18	0	0	0	0	0	0	R1	0	N1,L1	0	0	0	0	0	0	0	0	0	0	No	0	0
	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0
	23	0	0	0	0	0	0	N1,L1	N2,L2	L1	N1	0	0	0	0	0	0	0	0	0	Yes	1	1
	25	0	0	0	0	0	0	N1	0	N1,L1	N1	N1	0	0	0	0	0	0	0	0	No	0	0
	29	0	0	0	0	0	0	N2,L2,R1	N2,L2,R2	N2,L2,R2	N2,L2,R2	N2,L2,R2	N2,L2,R1	0	0	0	0	0	0	0	Yes	5	7
	30	0	0	0	0	0	0	N1	N1,R1	N1,L1	0	N1,L2,R1	N1,L2	L2	L2	L2	L2	0	0	0	Yes	6	11
	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0
35	0	0	0	0	0	0	R1	D1	0	0	0	0	0	0	0	0	0	0	0	No	0	0	
40	0	0	0	0	0	0	0	N1,R1	N1,L1	N1	0	0	0	0	0	0	0	0	0	No	0	1	
41	0	0	0	0	0	0	R1	N2,L1,R1	N2,L2,R2	N2,L2,R2	N2,L2,R2	0	0	0	0	0	0	0	0	Yes	4	8	
43	0	0	0	0	0	0	0	N1,L1	N2,L2	N1,L2	N1	0	0	0	0	0	0	0	0	Yes	2	6	
44	0	0	0	0	0	0	0	N1,L1	0	N1	0	0	0	0	0	0	0	0	0	No	0	3	

Clinical Descriptions: N=Nasal Discharge, O=Ocular Discharge, C=Cough, L=Nasal Lesions, D=Depression, R=Dyspnea; Severity: 0=Normal, 1=Mild, 2=Moderate to Severe

Bold indicates an affected calf with moderate to severe clinical signs

¹An affected calf is one with moderate to severe clinical signs of disease on any post-challenge day (score of 2)

²An affected calf is one with moderate to severe clinical signs of disease or rectal temperature $\geq 104.0^{\circ}\text{F}$ on any post-challenge day

TABLE 2: Rectal Temperatures

	Calf ID	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Affected ¹	Duration ²	Maximum
Controls	2	101.4	101.8	101.7	103.6	105.1	105.8	105.6	104.5	102.9	101.6	101.8	101.5	101.3	101.6	101.6	101.8	101.6	102.0	Yes	4	105.8
	4	102.2	102.0	101.5	101.9	102.4	104.5	105.5	103.4	102.7	100.3	101.3	100.9	101.8	101.3	100.6	101.4	101.1	102.0	Yes	2	105.5
	7	101.5	102.0	102.2	102.0	103.7	106.1	106.1	106.0	105.8	104.7	103.7	102.3	102.6	102.1	101.2	101.5	101.3	101.6	Yes	5	106.1
	9	101.6	102.1	101.7	102.3	105.4	104.2	105.4	105.7	104.4	104.4	102.2	101.6	100.8	102.6	103.6	104.0	103.5	102.5	Yes	12	105.7
	10	101.6	101.8	101.5	101.3	104.7	105.8	106.4	104.8	104.8	103.4	102.1	102.2	101.2	101.6	100.9	101.0	101.1	101.4	Yes	4	106.4
	12	102.3	102.1	102.8	104.5	106.0	105.8	106.0	104.2	103.1	101.1	102.3	101.2	101.0	101.0	101.3	101.9	102.0	102.2	Yes	5	106.0
	13	102.5	101.4	101.6	103.1	104.8	105.9	105.5	104.0	103.4	101.2	101.3	101.6	101.9	101.3	101.4	101.9	102.1	101.8	Yes	4	105.9
	17	101.4	101.8	101.6	102.0	102.5	104.7	105.3	105.2	105.5	104.5	104.4	103.1	101.7	102.3	102.1	102.3	101.7	101.5	Yes	6	105.5
	19	102.8	101.0	101.9	102.0	103.5	105.7	106.5	104.8	105.1	104.0	103.3	101.6	102.5	102.4	101.8	102.4	101.3	102.0	Yes	5	106.5
	20	102.6	101.1	101.5	101.6	104.3	105.7	104.7	104.1	103.2	102.5	101.9	101.7	101.4	101.7	101.4	101.4	101.9	101.4	Yes	4	105.7
	21	102.1	102.1	102.3	104.5	105.2	106.3	106.1	105.0	104.3	102.7	103.9	103.2	103.1	103.2	103.5	103.2	102.2	102.0	Yes	6	106.3
	27	102.3	101.8	101.6	101.7	104.1	105.5	106.1	105.0	104.1	103.1	103.6	101.0	101.6	101.7	102.0	102.3	102.1	102.8	Yes	5	106.1
	28	101.6	102.4	101.9	102.6	104.8	105.2	105.5	104.5	102.7	100.3	100.6	100.7	101.2	102.3	101.5	102.0	101.9	103.2	Yes	4	105.5
	32	101.8	101.2	101.5	102.9	104.9	105.8	105.9	104.8	103.8	102.5	102.8	101.8	101.0	102.0	101.3	102.1	102.4	101.9	Yes	4	105.9
	37	101.2	101.9	101.9	101.8	103.8	105.5	106.4	106.1	104.8	103.7	102.8	101.7	101.4	101.5	100.6	101.5	101.7	101.6	Yes	4	106.4
	38	101.9	102.0	101.8	101.7	104.3	105.5	106.2	105.1	103.9	102.5	101.8	101.0	101.7	101.5	101.8	101.9	101.1	101.5	Yes	4	106.2
	39	102.1	101.9	102.4	101.2	103.6	104.6	105.7	104.9	104.7	104.0	103.6	102.1	100.5	101.7	101.5	101.9	101.0	101.7	Yes	5	105.7
	42	102.1	101.6	105.1	104.0	104.0	105.2	105.3	105.2	104.7	104.6	102.8	102.1	101.4	102.2	100.7	101.7	101.5	101.2	Yes	8	105.3
	45	101.8	101.7	101.9	102.6	104.0	104.7	104.3	102.6	101.4	102.4	101.4	101.5	101.7	101.4	101.5	101.6	101.2	101.2	Yes	3	104.7
	46	102.7	101.2	102.1	101.9	103.3	104.8	106.1	105.0	104.6	103.6	104.1	102.8	102.2	102.1	101.7	101.5	101.2	102.0	Yes	6	106.1
Vaccinates	1	101.5	101.2	101.4	102.7	103.2	102.8	104.3	103.8	102.9	102.7	102.6	100.9	101.6	101.1	100.8	101.3	101.5	101.7	No	1	104.3
	3	102.1	101.6	101.4	103.2	104.7	105.6	103.3	103.5	102.5	101.5	102.2	102.3	101.5	101.5	101.7	101.7	101.3	101.9	Yes	2	105.6
	5	101.8	101.6	102.0	101.8	101.9	104.0	105.4	102.8	101.9	101.2	101.4	102.2	102.3	103.4	103.8	103.4	101.2	101.8	Yes	2	105.4
	6	102.2	101.7	102.0	101.2	101.6	102.3	102.7	101.6	101.8	101.4	102.1	101.9	102.0	101.7	101.8	102.0	101.4	102.0	No	0	102.7
	8	101.6	101.6	101.9	102.4	101.7	101.9	102.4	101.7	101.9	101.1	101.7	101.5	101.5	101.6	101.8	101.7	102.0	102.4	No	0	102.4
	11	101.2	101.3	102.0	102.3	101.4	102.9	104.1	102.0	101.7	101.6	100.8	103.0	101.3	104.6	103.1	102.3	102.1	102.1	No	8	104.6
	14	101.3	101.3	102.2	102.9	102.1	102.5	102.0	101.8	102.8	100.4	101.4	101.2	101.4	101.0	101.7	101.8	101.6	101.4	No	0	102.9
	15	102.3	102.2	101.3	102.1	103.0	103.8	104.0	102.7	101.9	101.0	101.3	100.6	102.2	101.8	104.2	104.3	102.7	101.9	Yes	10	104.3
	16	102.4	102.1	101.7	101.8	103.1	104.6	104.0	103.2	102.0	101.1	101.4	101.9	101.7	101.7	101.7	102.0	101.5	101.4	Yes	2	104.6
	18	102.4	102.0	101.8	101.7	102.5	102.5	102.1	102.6	101.9	101.0	101.3	101.8	101.5	101.1	101.7	102.0	101.6	102.1	No	0	102.6
	22	102.2	102.0	101.3	102.2	102.1	102.2	102.2	102.4	101.7	101.1	101.9	101.2	101.9	101.5	100.9	101.9	101.4	102.3	No	0	102.4
	23	102.4	101.6	101.2	102.2	103.7	103.5	103.5	102.2	101.4	101.0	101.4	102.1	100.8	101.0	101.7	101.6	102.3	101.8	No	0	103.7
	25	101.3	102.1	102.3	101.4	103.3	103.0	103.7	102.3	102.3	101.5	101.7	101.7	101.4	101.8	100.9	101.4	102.4	101.5	No	0	103.7
	29	102.1	101.6	101.7	102.7	104.8	105.2	104.3	105.7	102.5	102.4	101.9	101.3	101.3	101.6	101.9	102.1	102.1	101.6	Yes	4	105.7
	30	102.0	101.8	101.5	102.0	101.6	104.4	104.0	103.8	103.0	102.1	102.5	101.0	101.8	101.1	101.7	101.6	101.4	102.0	Yes	2	104.4
	34	102.2	101.3	102.5	102.1	101.4	101.6	102.3	102.1	101.8	103.4	103.1	103.9	102.2	101.7	101.6	102.3	101.6	102.0	No	0	103.9
	35	101.8	102.0	101.6	102.8	103.5	103.0	102.5	102.0	102.3	101.9	101.2	101.5	101.2	101.3	100.4	101.3	102.5	101.9	No	0	103.5
	40	102.7	102.5	102.3	102.1	102.5	104.7	103.4	103.0	102.7	101.8	101.5	102.0	100.9	102.1	101.9	101.7	102.0	101.9	No	1	104.7
	41	102.2	102.1	102.2	104.0	104.8	105.4	104.0	103.0	102.8	102.4	101.9	101.3	102.2	101.6	101.6	101.5	101.5	102.1	Yes	4	105.4
	43	101.4	101.7	101.9	102.7	104.9	104.8	103.4	102.6	101.3	101.6	102.1	102.3	101.5	101.1	101.5	101.6	101.2	101.5	Yes	2	104.9
44	101.9	101.5	101.5	101.9	101.4	103.9	105.6	104.8	104.2	101.5	101.3	101.7	101.9	101.8	101.4	102.6	102.3	102.1	Yes	3	105.6	

Bold indicates fever $\geq 104.0^{\circ}\text{F}$

¹An affected calf is one with a rectal temperature $\geq 104.0^{\circ}\text{F}$ for two or more consecutive days

²For determining duration, an affected calf is one with a rectal temperature $\geq 104.0^{\circ}\text{F}$ on any post-challenge day

TABLE 3: Nasal Swab Virus Shedding

	Calf ID	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Controls	2	0	3.5	6.5	7.3	7.5	7.1	7.3	5.7	4.5	2.5	1.9	0	0	0	0
	4	0	4.7	6.1	7.3	7.3	6.5	5.9	5.5	3.1	0	0	0	0	0	0
	7	0	5.1	8.1	8.9	7.7	6.9	6.9	6.5	5.5	4.3	3.1	1.9	0	0	0
	9	0	6.1	8.1	7.3	6.9	7.1	7.1	5.5	4.5	2.3	1.9	1.7	0	0	0
	10	0	5.1	7.1	8.1	7.1	5.9	6.5	5.3	3.7	2.7	0	0	0	0	0
	12	0	3.9	6.7	7.7	7.5	6.5	6.9	5.5	4.3	2.9	1.9	0	0	0	0
	13	0	4.7	6.1	7.7	7.3	6.5	6.7	4.5	3.9	1.7	0	0	0	0	0
	17	0	5.9	7.3	7.7	8.1	7.5	7.5	5.9	4.7	2.5	0	0	0	0	0
	19	0	4.7	6.7	8.5	7.7	6.9	7.3	5.9	4.5	3.7	2.3	0	0	0	0
	20	0	6.5	7.5	8.3	6.3	5.7	6.1	4.7	3.7	2.3	0	0	0	0	0
	21	0	3.7	7.1	8.5	7.7	7.3	6.5	5.9	3.9	2.7	2.1	0	0	0	0
	27	0	4.7	7.1	7.3	8.7	7.3	6.7	4.5	3.7	1.7	0	0	0	0	0
	28	0	4.5	6.7	7.5	7.7	7.5	7.1	5.3	4.3	3.7	2.7	0	0	0	0
	32	0	5.7	7.1	7.7	8.1	7.3	7.3	5.7	4.3	2.7	1.7	0	0	0	0
	37	0	4.9	6.7	6.9	7.9	6.7	7.1	5.9	4.7	3.1	2.3	0	0	0	0
	38	0	3.9	5.7	7.7	6.9	6.5	7.1	5.9	3.5	2.5	1.7	0	0	0	0
	39	0	4.1	7.1	8.5	8.3	7.1	6.9	5.9	4.5	3.7	2.1	1.7	1.7	0	0
	42	0	3.5	6.3	7.3	7.7	6.7	6.7	5.5	4.7	4.5	2.1	1.9	0	0	0
45	0	4.7	6.5	8.3	7.7	6.7	7.3	5.5	3.7	3.3	1.9	0	0	0	0	
46	0	4.9	7.1	8.1	7.7	5.7	6.7	6.3	5.5	3.5	1.9	0	0	0	0	
Vaccinates	1	0	3.7	6.3	7.9	7.5	6.9	6.7	5.3	3.9	2.5	1.9	0	0	0	0
	3	0	4.9	8.3	7.9	7.5	6.5	5.3	0	0	0	0	0	0	0	0
	5	0	3.5	7.1	7.1	6.9	7.1	6.3	3.1	0	0	0	0	0	0	0
	6	0	4.9	6.5	6.3	6.7	5.5	3.3	1.7	0	0	0	0	0	0	0
	8	0	3.9	5.9	5.1	4.5	4.1	2.5	0	0	0	0	0	0	0	0
	11	0	5.1	6.5	6.9	7.1	6.3	3.5	1.7	0	0	0	0	0	0	0
	14	0	4.7	5.9	7.3	6.3	7.3	4.7	1.9	1.7	0	0	0	0	0	0
	15	0	4.9	7.1	7.9	7.9	5.5	4.7	3.1	0	0	0	0	0	0	0
	16	0	4.7	6.3	7.5	6.5	6.5	5.3	2.3	0	0	0	0	0	0	0
	18	0	4.5	5.7	5.3	5.7	4.3	3.3	0	0	0	0	0	0	0	0
	22	0	2.5	3.5	1.9	3.3	2.1	1.9	0	0	0	0	0	0	0	0
	23	0	5.3	6.7	6.9	6.9	6.5	4.1	0	0	0	0	0	0	0	0
	25	0	5.1	6.9	6.7	5.9	5.5	3.7	0	0	0	0	0	0	0	0
	29	0	4.3	6.9	7.9	8.3	7.5	6.5	0	2.3	0	0	0	0	0	0
	30	0	4.5	7.3	7.5	7.5	6.7	5.7	4.1	2.1	0	0	0	0	0	0
	34	0	4.5	3.5	3.5	4.7	3.9	2.9	3.7	0	0	0	0	0	0	0
	35	0	4.9	7.3	6.9	4.7	5.7	4.1	1.9	0	0	0	0	0	0	0
	40	0	5.9	7.3	7.5	7.3	7.1	6.9	4.7	2.7	0	0	0	0	0	0
41	0	5.1	6.9	7.9	7.7	6.9	6.5	3.9	3.1	0	0	0	0	0	0	
43	0	4.5	7.3	6.9	7.3	6.7	5.7	3.5	0	0	0	0	0	0	0	
44	0	3.1	4.3	4.7	3.7	2.1	3.7	0	0	0	0	0	0	0	0	

Bold indicates positive nasal shedding (results are reported as Log₁₀ TCID₅₀/mL)

Study Type	Efficacy
Pertaining to	infectious bovine rhinotracheitis (IBR)
Study Purpose	Demonstrate effectiveness of the infectious bovine rhinotracheitis (IBR) fraction against respiratory disease caused by IBR
Product Administration	One dose administered intranasally
Study Animals	Forty-four colostrum deprived calves, less than 1 week of age, divided into two groups: 22 vaccinates and 22 controls
Challenge Description	Challenged intranasally with the virulent Cooper strain of IBR 29 days after vaccination
Interval observed after challenge	Calves observed daily for 17 days after challenge
Results	<p>Animals were considered affected by the challenge if they had moderate to severe (severity score of 2) clinical signs (nasal or ocular discharge, nasal lesions, dyspnea, depression, anorexia, and/or cough) on any day during the post-challenge period, or a rectal temperature $\geq 104.0^{\circ}\text{F}$ on any post-challenge day.</p> <p>For fever, an affected calf was one with a rectal temperature $\geq 104.0^{\circ}\text{F}$ for two or more consecutive post-challenge days.</p> <p>Totals: 22/22 controls affected 5/22 vaccinates affected</p> <p>Raw data: See attached.</p>
USDA Approval Date	January 3, 2018

TABLE 1: Clinical Observations

Group	Calf ID	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Affected ¹	Duration ²		
Controls	445	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	
	446	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
	450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
	451	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
	456	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
	458	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
	459	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
	460	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
	461	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
	464	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
	465	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
	466	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
	467	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
	470	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
	472	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
	475	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	476	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
479	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	
481	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	
482	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	
485	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	
486	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	
Vaccinates	443	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	444	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	447	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	448	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	452	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	453	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	454	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	455	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
	457	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	462	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	463	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
	468	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	469	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
	471	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	473	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	474	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	477	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
478	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
480	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
483	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
484	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	
486	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Clinical Descriptions: N=Nasal Discharge, O=Ocular Discharge, C=Cough, L=Nasal Lesions, D=Depression, R=Dyspnea, Severity: 0=Normal, 1=Mild, 2=Moderate to Severe, * =Fever
¹ An affected calf is one with moderate to severe clinical signs of disease on any post-challenge day (score of 2)
² For determining duration, an affected calf is one with moderate to severe clinical signs of disease or rectal temperature $\geq 104.0^{\circ}\text{F}$ on any post-challenge day

TABLE 2: Rectal Temperatures

Cal ID	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Affected	Duration ¹
Controls																		
445	101.6	101.7	101.3	101.3	104.1	105.1	104.4	105.0	104.6	103.7	103.3	101.9	100.4	101.2	100.9	101.4	Yes	5
446	102.1	101.2	101.1	101.0	103.2	104.3	104.0	103.9	103.5	102.9	102.0	101.8	100.6	101.2	101.2	101.0	Yes	2
450	101.9	102.2	102.3	102.4	104.0	105.6	106.1	104.8	103.6	102.7	102.1	102.3	101.4	101.9	101.6	101.2	Yes	4
451	102.8	101.7	101.8	102.3	103.1	104.3	102.5	104.0	103.8	103.7	103.0	101.5	101.5	102.6	101.6	101.7	No	3
456	101.7	102.4	101.1	101.8	104.5	104.9	104.2	104.2	103.8	106.0	104.9	104.9	101.9	101.2	101.1	102.3	Yes	6
458	101.7	101.1	101.3	101.0	104.5	104.4	103.5	104.8	102.8	102.7	102.5	101.7	100.2	101.1	100.8	101.6	Yes	4
459	102.0	102.0	101.1	101.6	103.6	103.6	104.0	103.3	102.1	101.1	101.5	101.5	100.4	101.6	100.4	101.0	No	1
460	102.5	101.2	101.6	101.4	102.5	104.7	104.0	103.8	102.2	101.1	101.0	101.4	100.0	101.3	101.0	101.2	Yes	2
461	102.2	101.6	101.3	101.9	104.8	105.0	104.2	104.0	103.3	101.6	101.3	101.1	101.1	101.3	101.4	101.4	Yes	4
464	101.3	101.3	100.9	101.0	103.2	105.0	104.2	104.8	103.0	102.1	101.6	102.0	99.8	101.1	101.0	101.1	Yes	4
465	102.2	102.0	101.0	101.1	102.4	104.0	104.0	101.5	101.3	101.5	101.2	101.1	100.6	101.5	100.0	101.0	Yes	2
466	101.3	102.0	101.4	101.0	103.9	104.3	104.0	102.8	102.4	101.0	101.4	101.4	100.6	101.5	101.7	101.4	Yes	2
467	102.2	100.8	101.8	101.3	103.7	104.4	102.7	102.9	103.1	103.4	102.4	101.7	101.1	101.3	100.9	101.6	No	1
470	102.8	101.4	101.8	101.5	103.0	104.6	104.2	104.3	104.1	104.6	104.6	104.1	101.0	101.3	100.8	101.1	Yes	7
472	102.1	101.0	100.5	101.6	105.0	105.2	103.9	104.3	103.6	102.7	101.6	102.0	100.1	101.6	101.2	101.5	Yes	4
473	102.4	101.5	101.8	102.2	105.1	105.2	103.5	103.6	102.6	102.0	101.6	101.7	100.2	102.0	101.1	102.0	Yes	2
475	101.3	100.8	100.1	101.0	103.2	104.3	103.3	103.9	103.0	102.1	103.0	102.2	100.6	100.6	100.5	100.3	No	1
479	101.4	101.1	102.3	101.6	103.0	104.4	104.8	103.6	104.4	102.0	101.9	101.9	100.7	100.2	101.5	101.1	Yes	4
481	101.7	101.1	100.9	101.3	104.0	104.3	104.0	104.5	104.1	102.2	101.6	101.5	100.3	101.2	100.6	100.5	Yes	5
482	101.7	101.1	100.4	100.9	104.0	105.2	103.6	104.3	102.4	101.1	101.5	101.1	100.8	102.1	100.8	100.9	Yes	4
485	101.7	101.3	101.0	101.7	104.5	104.4	106.1	104.3	104.5	103.1	102.3	102.6	100.5	101.0	100.7	101.0	Yes	5
488	101.0	101.9	101.0	101.6	101.5	103.8	101.2	102.7	102.7	102.4	101.3	101.7	100.2	101.1	101.1	101.0	No	0
Vaccinates																		
493	101.4	101.0	100.8	101.3	101.3	101.5	100.4	102.2	101.4	101.5	101.6	101.5	100.2	101.7	101.1	101.4	No	0
494	101.1	101.7	101.9	102.0	102.4	102.3	101.4	102.0	102.5	102.4	101.7	100.9	101.0	102.1	101.7	101.6	No	0
497	101.8	101.6	101.1	101.0	101.3	101.3	100.8	101.2	101.2	101.0	101.3	101.0	100.1	100.9	101.3	101.0	No	0
498	101.6	101.0	100.6	101.7	104.2	105.1	103.0	102.1	101.7	101.4	101.0	101.0	100.3	101.1	101.3	101.6	Yes	2
492	102.0	101.2	101.6	101.4	102.4	102.8	100.8	101.6	101.4	102.0	101.4	101.9	100.2	101.8	100.6	101.6	No	0
493	101.8	101.1	101.2	101.3	101.6	101.5	99.5	101.1	101.0	102.0	102.0	102.0	100.4	101.7	101.4	101.3	No	0
494	101.7	101.5	101.1	101.5	102.8	102.5	102.5	104.0	103.5	103.7	101.5	102.7	101.6	102.3	101.1	101.1	No	1
495	101.8	101.2	101.0	101.1	102.5	102.2	100.4	101.3	101.0	101.0	101.0	102.4	100.9	100.2	102.9	100.8	No	0
496	102.0	100.9	101.6	101.6	101.8	101.7	101.2	102.0	102.1	101.6	101.7	101.6	100.6	101.8	101.5	100.8	No	0
492	100.9	101.7	101.1	101.5	102.1	104.4	104.0	104.6	103.0	103.6	102.5	101.2	99.7	101.0	100.8	101.0	Yes	3
493	102.1	101.8	101.0	101.3	102.0	101.3	101.0	102.0	102.2	101.6	101.6	101.3	101.3	101.3	101.4	101.6	No	0
498	101.3	101.4	101.0	101.4	101.5	104.8	106.1	104.5	103.1	101.8	101.1	101.3	100.2	101.1	101.1	101.2	Yes	3
499	101.6	101.6	101.4	101.5	103.5	103.7	102.1	102.8	100.9	101.9	101.1	101.6	101.1	101.9	101.6	101.2	No	0
497	102.0	101.4	101.1	100.9	102.2	102.7	100.5	102.0	101.6	102.0	102.1	101.7	100.4	101.2	101.3	101.7	No	0
473	102.0	100.6	101.2	101.3	102.2	102.4	100.8	101.4	101.1	101.3	101.4	101.3	101.3	100.5	100.7	100.9	No	0
474	102.2	102.0	101.0	102.0	102.1	102.6	101.1	101.3	101.8	101.8	101.0	102.0	101.0	102.4	100.8	101.6	No	0
477	102.9	102.0	102.4	102.2	103.0	101.7	101.2	101.5	102.0	101.8	101.5	101.8	101.4	102.2	101.0	101.5	No	0
475	101.5	101.3	100.9	101.4	102.0	101.4	101.2	101.4	101.0	101.0	101.4	101.4	99.9	101.0	100.9	101.2	No	0
480	101.9	101.8	101.3	101.7	102.2	102.2	101.9	102.0	101.9	101.8	102.0	102.5	100.3	102.0	101.1	101.8	No	0
483	102.4	101.2	101.9	101.7	103.6	104.5	104.2	104.4	104.3	103.6	102.5	102.0	100.4	101.4	100.8	100.6	Yes	4
484	101.2	101.4	101.3	101.3	101.3	101.1	100.0	101.6	101.3	101.5	101.6	102.9	103.4	102.6	100.2	100.7	No	0
485	101.5	101.0	100.8	100.2	101.1	101.0	100.5	101.1	101.5	100.9	103.6	101.3	99.7	101.2	100.8	101.1	No	0

Bold indicates fever $\geq 104.0^{\circ}\text{F}$

¹An affected calf is one with a rectal temperature $\geq 104.0^{\circ}\text{F}$ for two or more consecutive days

²For determining duration, an affected calf is one with a rectal temperature $\geq 104.0^{\circ}\text{F}$ on any post-challenge day

Study Type	Efficacy
Pertaining to	<i>Mannheimia haemolytica</i>
Study Purpose	Demonstrate effectiveness of the <i>Mannheimia haemolytica</i> fraction against respiratory disease caused by <i>Mannheimia haemolytica</i>
Product Administration	One dose administered intranasally at 2 to 4 days of age
Study Animals	Colostrum deprived calves, two to four days of age, divided into two groups: Group A vaccinates, 22 calves, test vaccine with <i>Mannheimia haemolytica</i> antigen at the minimum protective dose (MPD) and the other five antigen fractions at or above proposed release levels. Group B controls, 22 calves, placebo vaccine containing all antigens at or above proposed release levels except <i>Mannheimia haemolytica</i>
Challenge Description	Challenged intratracheally (IT) with a virulent culture of <i>Mannheimia haemolytica</i> at 25 days post vaccination
Interval observed after challenge	Observed for clinical signs of the disease for 7 days post challenge. Lung tissues were examined.
Results	Vaccinates and controls were evaluated for clinical signs related to <i>Mannheimia haemolytica</i> infection. Number of calves with clinical signs on any day during post-challenge period: Table 1: Mortality Group A Vaccinates: 4/22 Group B Controls: 14/22 Table 3: Lung Lesion Score (LLS): Group A Vaccinates: mean LLS was 5.45 Group B Controls: mean LLS was 27.84 Raw data attached
USDA Approval Date	October 19, 2016

Table 1: Mortality

Group	Animal ID	Mortality (Yes or No)
Group A Vaccinates	284	No
	286	No
	287	No
	288	No
	292	Yes
	293	No
	294	No
	295	Yes
	296	No
	298	Yes
	301	No
	303	No
	309	No
	310	No
	311	No
	313	No
	314	No
	316	No
	317	Yes
	318	No
319	No	
323	No	
Group B Controls	280	Yes
	281	Yes
	282	Yes
	283	No
	285	Yes
	289	Yes
	290	Yes
	291	Yes
	297	No
	299	No
	300	Yes
	302	Yes
	304	Yes
	305	No
	306	No
	307	Yes
	308	Yes
	312	No
315	No	
320	No	
321	Yes	
322	Yes	

Table 2: Lung Lesion Scores

Calf ID	Treatment	Bact ID	Lung Lesion Score 1	Lung Lesion Score 2
280	Control	Mannheimia haemolytica	54.72	53.44
281	Control	Mannheimia haemolytica	39.71	36.41
282	Control	Mannheimia haemolytica	52.59	47.57
283	Control	Mannheimia haemolytica	36.79	31.86
285	Control	Mannheimia haemolytica	22.20	22.89
289	Control	Mannheimia haemolytica	45.52	42.92
290	Control	Mannheimia haemolytica	34.96	36.83
291	Control	Mannheimia haemolytica	23.93	19.85
297	Control	Mannheimia haemolytica	28.34	26.51
299	Control	Mannheimia haemolytica	10.23	9.32
300	Control	Mannheimia haemolytica	31.75	31.37
302	Control	Mannheimia haemolytica	51.47	48.68
284	Vaccinate	NA	0.53	0.66
286	Vaccinate	NA	0.15	0.22
287	Vaccinate	NA	0.00	0.00
288	Vaccinate	NA	0.94	0.88
292	Vaccinate	Mannheimia haemolytica	12.15	10.07
293	Vaccinate	NA	2.81	2.05
294	Vaccinate	Mannheimia haemolytica	22.26	19.67
295	Vaccinate	Mannheimia haemolytica	34.63	30.98
296	Vaccinate	NA	0.00	0.00
298	Vaccinate	Mannheimia haemolytica	5.27	5.75
301	Vaccinate	NA	0.65	0.68
303	Vaccinate	Mannheimia haemolytica	9.57	6.72
304	Control	Mannheimia haemolytica	44.34	41.19
305	Control	Mannheimia haemolytica	3.13	2.91
306	Control	Mannheimia haemolytica	4.37	4.30
307	Control	Mannheimia haemolytica	55.36	54.47
308	Control	Mannheimia haemolytica	17.88	15.24
312	Control	NA	0.12	0.12
315	Control	Mannheimia haemolytica	35.42	32.97
320	Control	Mannheimia haemolytica	0.68	0.91
321	Control	Mannheimia haemolytica	16.49	14.10
322	Control	Mannheimia haemolytica	21.57	19.62
309	Vaccinate	Mannheimia haemolytica	19.76	18.98
310	Vaccinate	Mannheimia haemolytica	0.73	0.78
311	Vaccinate	Mannheimia haemolytica	2.46	2.99
313	Vaccinate	Mannheimia haemolytica	1.03	0.98
314	Vaccinate	Mannheimia haemolytica	2.60	2.09
316	Vaccinate	Mannheimia haemolytica	3.13	2.93
317	Vaccinate	Mannheimia haemolytica	3.75	4.16
318	Vaccinate	Mannheimia haemolytica	1.54	1.64
319	Vaccinate	Mannheimia haemolytica	1.92	1.62
323	Vaccinate	NA	0.00	0.00

* Shaded calves died during post-challenge period due to challenge.

Table 3: Mean Lung Lesion Scores (LLS)

Group Serial A (Vaccinates)		Group Serial B (Placebo)	
Calf No.	LLS Average*	Calf No.	LLS Average*
284	0.596	280	54.0755
286	0.185	281	38.061
287	0	282	50.079
288	0.909	283	34.3215
292	11.109	285	22.5445
293	2.431	289	44.2205
294	20.9615	290	35.8935
295	32.8015	291	21.8895
296	0	297	27.425
298	5.5055	299	9.7775
301	0.663	300	31.564
303	8.1475	302	50.0745
309	19.3695	304	42.764
310	0.7565	305	3.0205
311	2.7255	306	4.336
313	1.0045	307	54.915
314	2.3445	308	16.5585
316	3.031	312	0.116
317	3.954	315	34.194
318	1.5885	320	0.794
319	1.7655	321	15.296
323	0	322	20.5925

* Lung Lesion Score average is based on the mean of two independent scorers.

Study Type	Efficacy																		
Pertaining to	<i>Mannheimia Haemolytica</i>																		
Study Purpose	Demonstrate duration of immunity (DOI) of the <i>Mannheimia haemolytica</i> fraction																		
Product Administration	One dose administered intranasally at 3 to 8 days of age																		
Study Animals	Forty-four colostrum deprived calves, 3 to 8 days of age, divided into two groups: Group A, 21 calves (1 animal died prior to vaccination), test vaccine with <i>M. haemolytica</i> antigen at the minimum protective dose (MPD) and the other four antigen fractions at or above proposed release levels. Group B, 22 calves, placebo vaccine containing all antigens at or above proposed release levels except <i>M. haemolytica</i>																		
Challenge Description	Challenged with a virulent culture of <i>M. haemolytica</i> at 122 days post vaccination																		
Interval observed after challenge	Observed for clinical signs of the disease for 7 days post challenge then tissues examined																		
Results	<p>Vaccinates and controls were for lung lesions due to <i>M. Haemolytica</i> infection.</p> <p>Results: Lung Lesion Score (LLS):</p> <p style="text-align: center;"><i>Percent lung lesions</i></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th><i>Group</i></th> <th><i>Minimum</i></th> <th><i>Q1</i></th> <th><i>Median</i></th> <th><i>Q3</i></th> <th><i>Maximum</i></th> </tr> </thead> <tbody> <tr> <td><i>Vaccinate</i></td> <td>0</td> <td>0</td> <td>1</td> <td>3</td> <td>44</td> </tr> <tr> <td><i>Control</i></td> <td>0</td> <td>3</td> <td>9</td> <td>42</td> <td>56</td> </tr> </tbody> </table> <p><i>Q=Quartile</i></p> <p>Raw data attached</p>	<i>Group</i>	<i>Minimum</i>	<i>Q1</i>	<i>Median</i>	<i>Q3</i>	<i>Maximum</i>	<i>Vaccinate</i>	0	0	1	3	44	<i>Control</i>	0	3	9	42	56
<i>Group</i>	<i>Minimum</i>	<i>Q1</i>	<i>Median</i>	<i>Q3</i>	<i>Maximum</i>														
<i>Vaccinate</i>	0	0	1	3	44														
<i>Control</i>	0	3	9	42	56														
USDA Approval Date	May 3, 2019																		

Table 1 Mean Lung Lesion Scores (LLS)

Serial A				Serial B (Placebo)			
	LLS				LLS		
Calf No.	Scorer 1	Scorer 2	Average	Calf No.	Scorer 1	Scorer 2	Average
503	0.000	0.000	0.000	502	54.494	57.879	56.187
505	5.136	5.022	5.079	504	0.645	0.896	0.771
507	0.000	0.000	0.000	506	2.855	3.673	3.264
509	0.269	0.615	0.442	508	43.293	43.064	43.479
514	18.079	16.343	17.211	510	48.781	51.728	50.255
517	2.045	3.518	2.782	511	46.652	47.498	47.075
518	0.584	0.606	0.595	512	47.625	47.365	47.495
519	0.000	0.000	0.000	515	39.843	41.005	40.424
522	0.123	0.185	0.154	516	0.000	0.000	0.000
524	0.555	1.000	0.778	520	13.975	14.039	14.007
525	13.209	13.180	13.195	521	25.948	27.734	26.841
527	10.890	10.819	10.855	523	46.733	44.276	45.505
528	1.044	1.666	1.355	526	0.000	0.000	0.000
529	1.559	1.699	1.629	532	1.220	1.559	1.390
530	47.899	40.756	44.328	533	8.141	8.343	8.242
531	2.562	3.242	2.902	534	3.103	3.838	3.471
536	0.219	0.438	0.329	535	5.921	6.157	6.039
540	0.507	0.896	0.702	537	31.095	29.364	30.230
541	0.593	0.742	0.668	538	0.318	0.516	0.417
543	0.000	0.000	0.000	539	11.111	10.385	10.748
544	0.039	0.195	0.117	542	4.431	6.113	5.272
				545	6.959	7.682	7.321

Note: Lung Lesion Score average is based on the mean of two independent scorers.

Summary of *M. haemolytica* isolations from lung tissue samples

Group	No. of isolations
A (Vaccine)	7
B (Placebo)	15

Study Type	Efficacy																		
Pertaining to	<i>Parainfluenza 3 (PI3)</i>																		
Study Purpose	Demonstrate effectiveness of the <i>Parainfluenza 3</i> fraction against respiratory disease caused by <i>Parainfluenza 3</i>																		
Product Administration	One dose administered intranasally at 6 or 7 days of age																		
Study Animals	Colostrum deprived calves, 6 or 7 days of age, divided into two groups: Group A vaccinates, 22 calves, test vaccine with <i>Parainfluenza 3</i> antigen at the minimum protective dose (MPD) and the other seven antigen fractions at or above release levels Group B controls, 13 calves, placebo vaccine with the seven antigen fractions at or above release levels and without the <i>Parainfluenza 3</i> fraction																		
Challenge Description	Challenged with a virulent <i>Parainfluenza 3</i> at either 39 (1 st shipment) or 32 (2 nd shipment) days post vaccination																		
Interval observed after challenge	Observed for clinical signs of the disease for 14 days post challenge																		
Results	Vaccinates and controls were evaluated for viral shedding as virus shedding is the primary criteria related to <i>Parainfluenza 3</i> infection. Number of calves with viral shedding and days duration during post-challenge period: Group A Vaccinates: 13/22 shed PI3 post-challenge Group B Controls: 13/13 shed PI3 post-challenge <i>Duration (days) of shedding, five number summary</i> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th><i>Group</i></th> <th><i>Min</i></th> <th><i>Q₁</i></th> <th><i>Median</i></th> <th><i>Q₃</i></th> <th><i>Max</i></th> </tr> </thead> <tbody> <tr> <td>Vaccinates</td> <td>0</td> <td>0</td> <td>1</td> <td>4</td> <td>8</td> </tr> <tr> <td>Controls</td> <td>5</td> <td>7</td> <td>9</td> <td>9</td> <td>10</td> </tr> </tbody> </table> Raw data attached	<i>Group</i>	<i>Min</i>	<i>Q₁</i>	<i>Median</i>	<i>Q₃</i>	<i>Max</i>	Vaccinates	0	0	1	4	8	Controls	5	7	9	9	10
<i>Group</i>	<i>Min</i>	<i>Q₁</i>	<i>Median</i>	<i>Q₃</i>	<i>Max</i>														
Vaccinates	0	0	1	4	8														
Controls	5	7	9	9	10														
USDA Approval Date	September 24, 2014																		

Table 1: Nasal Swab Virus Shedding Results

Group	ID	Nasal PI3 Virus Titer (Log ₁₀ TCID ₅₀ /mL) Day Post-Challenge												
		Vac. ¹	-1	0	1	2	3	4	5	6	7	8	9	10
Controls	202	0	0	0	0	1.7	2.5	2.7	3.5	3.5	2.3	1.9	3.9	2.9
	206	0	0	0	3.1	4.3	5.3	5.5	5.9	4.1	2.1	0	0	0
	207	0	0	0	0	1.7	3.9	4.9	4.5	3.7	2.3	0	0	1.7
	212	0	0	0	0	0	3.7	3.1	4.7	5.9	3.3	3.1	3.3	0
	213	0	0	0	1.7	2.5	3.7	3.9	4.5	5.5	4.5	2.9	2.3	0
	220	0	0	0	0	3.1	3.9	4.5	5.7	6.3	3.1	2.5	3.9	1.7
	222	0	0	0	0	1.9	2.5	3.7	5.7	4.9	3.3	2.3	2.7	3.7
	223	0	0	0	0	2.1	2.7	2.7	3.1	3.5	2.5	1.9	2.1	2.1
	230	0	0	0	0	1.9	3.9	4.7	5.3	4.5	2.9	2.5	3.5	2.7
	231	0	0	0	0	1.7	1.7	1.7	2.3	2.5	0	0	0	0
	234	0	0	0	0	0	1.7	3.7	4.9	3.9	2.1	0	0	0
	236	0	0	0	3.3	4.3	4.5	5.7	5.7	4.9	2.7	3.5	2.5	2.1
	242	0	0	0	0	0	1.9	3.7	4.7	5.1	3.7	2.7	0	0
	Average:	0	0	0	0.6	1.9	3.2	3.9	4.7	4.5	2.7	1.8	1.9	1.3
Vaccinates	201	0	0	0	0	0	0	0	0	0	0	0	0	0
	203	0	0	0	0	0	1.9	0	0	0	0	0	0	0
	204	0	0	0	0	0	0	0	0	0	0	0	0	0
	205	0	0	0	0	3.5	4.3	4.7	3.9	0	0	0	0	0
	208	0	0	0	0	0	0	1.7	0	0	0	0	0	0
	211	0	0	0	1.7	2.7	5.7	3.7	1.7	0	0	0	0	0
	215	0	0	0	0	1.7	0	0	0	0	0	0	0	0
	217	0	0	0	0	0	0	1.7	0	0	0	0	0	0
	218	0	0	0	0	0	0	0	0	0	0	0	0	0
	224	0	0	0	1.7	2.9	2.7	3.7	3.3	0	0	0	0	0
	225	0	0	0	0	0	1.7	2.1	2.3	3.3	3.1	0	1.7	0
	226	0	0	0	0	0	0	0	0	0	0	0	0	0
	227	0	0	0	0	0	2.3	3.5	2.5	0	0	0	0	0
	228	0	0	0	0	1.7	1.7	1.7	0	0	0	0	0	0
	229	0	0	0	0	1.7	2.9	3.3	2.7	0	0	0	0	0
	232	0	0	0	0	0	2.7	3.5	3.7	3.9	2.7	1.9	2.5	1.9
	233	0	0	0	0	1.9	2.5	0	0	0	0	0	0	0
	235	0	0	0	0	0	0	0	0	0	0	0	0	0
237	0	0	0	0	0	0	0	0	0	0	0	0	0	
239	0	0	0	0	0	0	0	0	0	0	0	0	0	
240	0	0	0	0	0	0	0	0	0	0	0	0	0	
241	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Average:	0	0	0	0.2	0.7	1.3	1.3	0.9	0.3	0.3	0.1	0.2	0.1

¹Prior to vaccination (study day 0 or 7)

Study Type	Efficacy																		
Pertaining to	<i>Parainfluenza 3</i>																		
Study Purpose	Demonstrate Duration of Immunity (effectiveness) of the <i>Parainfluenza 3</i> fraction against respiratory disease caused by <i>Parainfluenza 3</i>																		
Product Administration	One dose administered intranasally at 3 to 5 days of age																		
Study Animals	44 Colostrum deprived calves, 3 to 5 days of age, divided into two groups: Group A vaccinates, 22 calves, test vaccine Group B controls, 22 calves, placebo vaccine																		
Challenge Description	Challenged with virulent <i>Parainfluenza 3</i> at 95 days post vaccination																		
Interval observed after challenge	Observed for clinical signs of the disease for 14 days post challenge																		
Results	<p>Number of calves with viral shedding during post-challenge period: Group A Vaccinates: 18/20 shed PI3 post-challenge Group B Controls: 20/20 shed PI3 post-challenge</p> <p>Duration of shedding in days:</p> <table border="1"> <thead> <tr> <th><i>Group</i></th> <th><i>Minimum</i></th> <th><i>Q1</i></th> <th><i>Median</i></th> <th><i>Q3</i></th> <th><i>Maximum</i></th> </tr> </thead> <tbody> <tr> <td><i>Vaccinate</i></td> <td>0</td> <td>2</td> <td>3.5</td> <td>5</td> <td>7</td> </tr> <tr> <td><i>Control</i></td> <td>6</td> <td>6</td> <td>6.0</td> <td>7</td> <td>8</td> </tr> </tbody> </table> <p><i>Q=quartile</i></p> <p>NOTE: 1 control animal was removed from the study prior to vaccination. Two vaccinates and 1 control animal were removed or humanely euthanized, for reasons unrelated to vaccination, prior to challenge.</p> <p>Raw data attached</p>	<i>Group</i>	<i>Minimum</i>	<i>Q1</i>	<i>Median</i>	<i>Q3</i>	<i>Maximum</i>	<i>Vaccinate</i>	0	2	3.5	5	7	<i>Control</i>	6	6	6.0	7	8
<i>Group</i>	<i>Minimum</i>	<i>Q1</i>	<i>Median</i>	<i>Q3</i>	<i>Maximum</i>														
<i>Vaccinate</i>	0	2	3.5	5	7														
<i>Control</i>	6	6	6.0	7	8														
USDA Approval Date	February 21, 2019																		

Table 1: Nasal Swab Virus Shedding Results

CalfID	0 PV	-1 PC	1 PC	2 PC	3 PC	4 PC	5 PC	6 PC	7 PC	8 PC	9 PC	10 PC	Duration (days)
Controls													
214	0	0	2.7	3.7	4.5	5.3	6.1	2.9	0	0	0	0	6
215	0	0	2.5	4.1	4.7	5.7	6.1	4.9	0	0	0	0	6
217	0	0	3.3	3.1	3.7	4.5	4.5	2.5	1.7	1.7	0	0	8
218	0	0	3.9	3.3	4.5	4.7	5.1	4.7	0	0	0	0	6
219	0	0	3.5	3.5	4.5	5.7	6.1	4.9	0	0	0	0	6
222	0	0	2.7	4.3	5.5	6.7	5.9	3.5	1.7	0	0	0	7
227	0	0	3.7	4.1	3.9	5.1	5.1	1.9	0	0	0	0	6
230	0	0	4.3	5.9	4.5	5.1	6.3	2.9	1.7	0	0	0	7
231	0	0	4.1	4.9	4.7	6.1	6.3	5.7	2.7	1.7	0	0	8
233	0	0	2.9	4.3	5.9	4.9	6.7	4.5	2.1	0	0	0	7
236	0	0	2.9	4.9	6.7	5.3	4.9	2.9	0	0	0	0	6
237	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
239	0	0	3.7	4.7	4.9	4.9	5.9	4.3	2.1	0	0	0	7
241	0	0	3.9	4.1	4.1	5.5	5.5	3.5	0	0	0	0	6
243	0	0	2.9	4.9	5.1	5.7	5.1	3.5	0	0	0	0	6
245	0	0	3.1	4.3	4.3	4.7	4.5	3.9	0	0	0	0	6
247	0	0	3.1	3.3	3.3	4.7	4.7	3.1	0	0	0	0	6
248	0	0	3.3	4.5	4.7	5.3	6.1	2.7	0	0	0	0	6
250	0	0	4.3	5.5	6.1	6.7	6.5	2.9	0	0	0	0	6
252	0	0	3.7	4.9	5.9	6.7	7.1	4.5	2.1	1.7	0	0	8
255	0	0	3.7	4.9	5.9	6.7	7.1	4.5	2.1	1.7	0	0	8
Vaccinates													
212	0	0	3.3	2.5	3.5	2.9	2.7	0	0	0	0	0	5
213	0	0	0	0	0	1.7	1.9	0	0	0	0	0	2
216	0	0	2.3	0	0	0	0	0	0	0	0	0	1
220	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
221	0	0	2.5	2.9	3.5	4.5	3.1	0	0	0	0	0	5
223	0	0	1.9	0	1.7	1.7	0	0	0	0	0	0	4
225	0	0	2.3	1.7	0	0	1.7	0	0	0	0	0	5
226	0	0	0	0	0	0	0	0	0	0	0	0	0
228	0	0	0	0	0	0	2.3	0	0	0	0	0	1
229	0	0	0	0	0	0	0	0	0	0	0	0	0
232	0	0	2.5	1.7	0	1.7	0	0	0	0	0	0	4
234	0	0	2.1	3.3	2.1	0	0	0	0	0	0	0	3
235	0	0	1.7	0	0	1.7	0	0	0	0	0	0	4
238	0	0	1.9	1.7	0	0	0	0	0	0	0	0	2
240	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
242	0	0	3.5	3.3	4.5	5.5	5.5	5.1	1.9	0	0	0	7
244	0	0	1.9	0	0	2.3	0	0	0	0	0	0	4
246	0	0	2.3	2.1	1.7	0	0	0	0	0	0	0	3
249	0	0	3.3	2.7	4.1	4.9	4.5	0	0	0	0	0	5
251	0	0	4.1	2.9	2.5	2.9	2.9	0	0	0	0	0	5
253	0	0	2.7	2.1	2.9	0	0	0	0	0	0	0	3
254	0	0	1.7	1.9	0	0	0	0	0	0	0	0	2

PV=post-vaccination, PC=post-challenge; **Bold** indicates positive nasal shedding

Study Type	Efficacy																		
Pertaining to	<i>Pasteurella multocida</i>																		
Study Purpose	Demonstrate duration of immunity (DOI) of the <i>Pasteurella Multocida</i> fraction																		
Product Administration	One dose administered intranasally at 2 to 3 days of age																		
Study Animals	Forty-four colostrum deprived calves, two to three days of age, divided into two groups: Group A, 22 calves, vaccine with <i>P. multocida</i> antigen at the minimum protective dose (MPD) and the other four antigen fractions at or above proposed release levels. Group B, 22 calves, placebo vaccine containing all antigens at or above proposed release levels except <i>P. multocida</i>																		
Challenge Description	Challenged with a virulent culture of <i>P. multocida</i> at 125 days post vaccination																		
Interval observed after challenge	Observed for for 7 days post challenge then tissues were examined																		
Results	<p>Vaccinates and controls were evaluated for lung lesions due to <i>P. multocida</i> infection. 1 animal in Group B was found dead on day 14 post vaccination.</p> <p>Results: Lung Lesion Score (LLS):</p> <p><i>Table 1: Percent lung lesions</i></p> <table border="1"> <thead> <tr> <th><i>Group</i></th> <th><i>Minimum</i></th> <th><i>Q1</i></th> <th><i>Median</i></th> <th><i>Q3</i></th> <th><i>Maximum</i></th> </tr> </thead> <tbody> <tr> <td><i>Vaccinate</i></td> <td>0</td> <td>1</td> <td>2</td> <td>4</td> <td>20</td> </tr> <tr> <td><i>Control</i></td> <td>1</td> <td>15</td> <td>23</td> <td>30</td> <td>45</td> </tr> </tbody> </table> <p><i>Q= quartile</i></p> <p>Raw data attached</p>	<i>Group</i>	<i>Minimum</i>	<i>Q1</i>	<i>Median</i>	<i>Q3</i>	<i>Maximum</i>	<i>Vaccinate</i>	0	1	2	4	20	<i>Control</i>	1	15	23	30	45
<i>Group</i>	<i>Minimum</i>	<i>Q1</i>	<i>Median</i>	<i>Q3</i>	<i>Maximum</i>														
<i>Vaccinate</i>	0	1	2	4	20														
<i>Control</i>	1	15	23	30	45														
USDA Approval Date	March 29, 2019																		

Mean Lung Lesion Scores (LLS)

Serial A				Serial B (Placebo)			
	LLS				LLS		
Calf No.	Scorer 1	Scorer 2	Average	Calf No.	Scorer 1	Scorer 2	Average
257	2.349	2.741	2.545	256	33.178	27.630	30.404
258	0.148	0.371	0.260	262	24.510	22.361	23.436
259	1.788	1.401	1.595	263	39.362	40.902	40.132
260	7.683	13.431	10.557	264	42.312	33.935	38.124
261	2.776	3.061	2.918	265	18.086	12.789	15.438
266	2.949	2.059	2.504	267	26.573	21.952	24.262
269	22.091	18.259	20.175	268	17.334	19.131	18.232
271	3.611	6.158	4.884	270	47.455	43.424	45.440
274	8.000	9.075	8.538	272	24.965	14.918	19.942
277	0.156	0.195	0.175	273	27.068	21.904	24.486
278	0.584	0.476	0.530	275	7.248	4.041	5.645
279	2.282	2.098	2.190	276	0.787	0.405	0.596
283	12.090	15.553	13.821	280	24.416	17.699	21.057
287	1.955	2.984	2.469	282	31.515	36.674	34.094
288	2.015	1.825	1.920	284	29.961	21.905	25.933
290	5.012	7.081	6.047	285	14.728	13.355	14.041
291	1.533	2.886	2.210	286	29.371	31.865	30.618
292	0.328	0.000	0.164	289	1.808	2.218	2.013
293	1.528	2.828	2.178	295	21.054	14.808	17.931
294	0.000	0.093	0.047	298	8.958	5.193	7.076
296	2.250	2.740	2.495	299	29.060	27.253	28.157
297	0.900	1.342	1.121				

* Lung Lesion Score average is based on the mean of two independent scorers.

Summary of *P. multocida* isolations from lung tissue samples

Group	No. of isolations
1 (Vaccinate)	7
2 (Placebo)	21

Study Type	Efficacy																		
Pertaining to	<i>Pasteurella multocida</i>																		
Study Purpose	Demonstrate effectiveness of the <i>Pasteurella multocida</i> fraction against respiratory disease caused by <i>Pasteurella multocida</i>																		
Product Administration	One dose administered intranasally at 1 to 4 days of age																		
Study Animals	Colostrum deprived calves, one to four days of age, divided into two groups: Group A vaccinates, 22 calves, test vaccine with <i>P. multocida</i> antigen at the minimum protective dose and the other five antigen fractions at or above proposed release levels. Group B controls, 20 calves, placebo vaccine containing all antigens at or above proposed release levels except <i>P. multocida</i>																		
Challenge Description	Challenged intratracheally (IT) with a virulent culture of <i>P. multocida</i> at 26 days post vaccination																		
Interval observed after challenge	Observed for clinical signs of the disease for 7 days post challenge. Lung tissue was examined day 7 post challenge.																		
Results	<p>Percent Lung Consolidation: Five-Number Summary (Min=Minimum, Q25 = 25th Percentile, Q50=Median, Q5 = 75th Percentile, Max=Maximum)</p> <table border="1"> <thead> <tr> <th>Treatment</th> <th>Min</th> <th>Q25</th> <th>Q50</th> <th>Q75</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Vaccinates</td> <td>0.0</td> <td>0.0</td> <td>0.5</td> <td>0.9</td> <td>16.1</td> </tr> <tr> <td>Controls</td> <td>0.9</td> <td>4.2</td> <td>7.8</td> <td>13.4</td> <td>25.5</td> </tr> </tbody> </table> <p>Raw data attached</p>	Treatment	Min	Q25	Q50	Q75	Max	Vaccinates	0.0	0.0	0.5	0.9	16.1	Controls	0.9	4.2	7.8	13.4	25.5
Treatment	Min	Q25	Q50	Q75	Max														
Vaccinates	0.0	0.0	0.5	0.9	16.1														
Controls	0.9	4.2	7.8	13.4	25.5														
USDA Approval Date	October 19, 2016																		

Table 1: Lung Lesion Scores (LLS)

Calf ID	Treatment	Bact ID	Lung Lesion Score 1	Lung Lesion Score 2
188	Control	Pasteurella multocida	8.847	6.681
191	Control	NA	10.407	10.027
192	Control	NA	5.573	5.57
196	Control	NA	1.627	1.934
197	Control	Pasteurella multocida	12.255	13.016
199	Control	NA	4.399	4.564
200	Control	NA	3.465	3.23
201	Control	NA	21.179	25.018
203	Control	Pasteurella multocida	3.8	3.55
209	Control	NA	10.983	8.755
212	Control	NA	15.416	14.766
213	Control	NA	9.461	6.275
216	Control	NA	1.091	0.72
218	Control	Pasteurella multocida	6.567	7.11
219	Control	Pasteurella multocida	24.436	26.501
225	Control	NA	5.364	4.429
226	Control	Pasteurella multocida	4.33	3.542
228	Control	Pasteurella multocida	17.93	19.675
230	Control	NA	14.734	13.814
231	Control	NA	10.85	8.109
189	Vaccinate	NA	0.415	0.361
190	Vaccinate	NA	0	0
193	Vaccinate	Pasteurella multocida	5.464	7.04
194	Vaccinate	NA	0	0
195	Vaccinate	NA	0.496	0.718
202	Vaccinate	NA	0.86	0.958
204	Vaccinate	Pasteurella multocida	8.257	10.226
205	Vaccinate	NA	0	0
207	Vaccinate	NA	0.527	1.007
208	Vaccinate	NA	0.698	1.161
210	Vaccinate	Pasteurella multocida	1.886	3.328
211	Vaccinate	NA	0	0
214	Vaccinate	NA	0	0
215	Vaccinate	NA	0.11	0.322
217	Vaccinate	NA	0	0
220	Vaccinate	Pasteurella multocida	18.044	14.056
221	Vaccinate	NA	0	0
222	Vaccinate	NA	0	0
223	Vaccinate	NA	0.541	0.797
224	Vaccinate	NA	2.504	5.694
227	Vaccinate	NA	0.419	0.476
229	Vaccinate	NA	0.646	1.146

Lung Lesion Score average is based on two independent scorers.

Table 2: Mean Lung Lesion Scores (LLS)

Group A (Vaccinates)		Group B (Placebo)	
Calf No.	LLS Average*	Calf No.	LLS Average*
189	0.388	188	7.764
190	0.000	191	10.217
193	6.252	192	5.572
194	0.000	196	1.781
195	0.607	197	12.636
202	0.909	199	4.482
204	9.242	200	3.348
205	0.000	201	23.099
207	0.767	203	3.675
208	0.930	209	9.869
210	2.607	212	15.091
211	0.000	213	7.868
214	0.000	216	0.906
215	0.216	218	6.839
217	0.000	219	25.469
220	16.050	225	4.897
221	0.000	226	3.936
222	0.000	228	18.803
223	0.669	230	14.274
224	4.099	231	9.480
227	0.448		
229	0.896		

* Lung Lesion Score average is based on the mean of two independent scorers.

Study Type	Efficacy																		
Pertaining to	Bovine Respiratory Syncytial Virus (BRSV)																		
Study Purpose	To demonstrate efficacy of the BRSV fraction																		
Product Administration	One dose administered intranasally at 1 week of age																		
Study Animals	<p>Forty-four calves, less than one week-of-age, divided into two groups:</p> <p>Group 1, 22 calves, vaccine with BRSV antigen at the minimum protective dose (MPD) and the other four antigen fractions at or above proposed release levels.</p> <p>Group 2, 22 calves, placebo vaccine containing all antigens at or above proposed release levels but without BRSV</p>																		
Challenge Description	Challenged with aerosolized virulent BRSV virus (two mL of challenge virus was administered per naris), at 30 days and again at 31 days after vaccination.																		
Interval observed after challenge	Observed daily for 8 days.																		
Results	<p>Three Group 2 calves died or were euthanized prior to challenge, therefore Group 2 is 19 calves.</p> <p>BRSV Nasal Virus Shedding: Group 1 Vaccinates: 7/22 Group 2 Controls: 16/19</p> <p>Lung Lesion Score (LLS):</p> <table border="1"> <thead> <tr> <th>Group</th> <th>Min</th> <th>Q1</th> <th>Med</th> <th>Q3</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Vaccinate</td> <td>0</td> <td>0</td> <td>0</td> <td>0.1</td> <td>11.3</td> </tr> <tr> <td>Control</td> <td>0.2</td> <td>0.9</td> <td>2.1</td> <td>5.35</td> <td>13.7</td> </tr> </tbody> </table> <p>Min is minimum Q is quartile Med is median Max is maximum</p> <p>Raw data attached</p>	Group	Min	Q1	Med	Q3	Max	Vaccinate	0	0	0	0.1	11.3	Control	0.2	0.9	2.1	5.35	13.7
Group	Min	Q1	Med	Q3	Max														
Vaccinate	0	0	0	0.1	11.3														
Control	0.2	0.9	2.1	5.35	13.7														
USDA Approval Date	January 3, 2018																		

Nasal BRSV Titer (TCID₅₀/mL)

Group	ID	-1	2	3	4	5	6	7	8	Duration (days)
Controls	342	0	0	0	0	0	0	0	0	0
	343	0	0	0	0	0	1.21E+02	2.70E+01	0	2
	344	0	0	0	0	1.28E+01	2.56E+02	1.86E+01	2.70E+01	4
	346	0	0	0	0	3.93E+01	5.72E+01	1.86E+01	1.28E+01	4
	348	0	0	0	0	0	0	1.28E+01	0	1
	349	0	0	0	0	0	0	1.86E+01	1.28E+01	2
	352	0	0	0	0	1.86E+01	2.70E+01	0	0	2
	355	0	0	0	1.86E+01	1.28E+01	5.72E+01	2.70E+01	0	4
	360	0	0	0	0	0	3.93E+01	5.72E+01	0	2
	361	0	0	0	1.86E+01	2.70E+01	2.70E+01	0	0	3
	366	0	0	0	0	1.86E+01	1.86E+01	0	0	2
	367	0	0	0	2.70E+01	2.70E+01	2.70E+01	1.28E+01	0	4
	368	0	0	0	0	1.28E+01	0	1.21E+02	0	3
	371	0	0	0	1.28E+01	8.32E+01	2.70E+01	8.32E+01	1.28E+01	5
	373	0	0	0	1.28E+01	0	3.93E+01	2.70E+01	0	4
	375	0	0	0	0	0	0	0	0	0
	377	0	0	0	0	0	0	0	0	0
	382	0	0	0	0	0	3.93E+01	3.93E+01	0	2
384	0	0	0	0	0	2.70E+01	1.28E+01	1.28E+01	3	
Vaccinates	347	0	0	0	0	0	0	0	0	0
	350	0	0	0	1.28E+01	3.93E+01	1.76E+02	5.72E+01	0	4
	351	0	0	0	0	0	0	0	0	0
	353	0	0	0	0	1.28E+01	2.70E+01	1.28E+01	0	3
	354	0	0	0	0	0	0	0	0	0
	356	0	0	0	0	1.86E+01	1.28E+01	0	0	2
	357	0	0	0	0	0	0	0	0	0
	358	0	0	0	0	0	0	0	0	0
	359	0	0	0	0	0	0	0	0	0
	362	0	0	1.28E+01	0	1.86E+01	1.28E+01	0	0	4
	363	0	0	0	1.28E+01	1.86E+01	0	0	0	2
	364	0	0	0	0	0	0	0	0	0
	369	0	0	0	0	0	0	0	0	0
	370	0	0	0	0	0	0	1.28E+01	1.28E+01	2
	372	0	0	0	0	0	0	0	0	0
	374	0	0	0	0	0	0	0	0	0
	376	0	0	0	3.93E+01	1.76E+02	5.43E+02	1.86E+01	0	4
	379	0	0	0	0	0	0	0	0	0
380	0	0	0	0	0	0	0	0	0	
381	0	0	0	0	0	0	0	0	0	
383	0	0	0	0	0	0	0	0	0	
385	0	0	0	0	0	0	0	0	0	

Bold indicates presence of viral shedding

Lung Lesion Score by Lung Lobe

Group	Calf ID	L Cranial	L Middle	L Caudal	R Cranial	R Post Cranial	R Middle	R Caudal	Accessory	Total Lung Score
Controls	342	2	5	1	0	0	0	0	0	0.7
	343	0	0	0	5	0	0	0	0	0.3
	344	30	20	10	40	10	10	5	10	11.7
	346	0	5	0	5	5	0	0	0	0.9
	348	0	5	5	2	0	2	0	0	2.2
	349	0	0	2	10	0	0	0	5	1.4
	352	0	20	10	25	0	15	10	10	10.9
	355	0	0	2	5	5	15	5	5	4.2
	360	5	5	2	10	2	10	5	0	4.3
	361	1	50	15	60	2	30	0	2	13.7
	366	5	15	5	2	2	15	2	1	4.8
	367	0	0	0	20	0	2	0	0	1.3
	368	2	2	0	0	0	0	0	0	0.2
	371	5	10	2	20	0	15	5	10	5.9
	373	0	5	2	2	0	2	0	5	1.4
	375	0	10	0	5	2	15	0	0	2.1
	377	0	0	2	2	0	2	0	0	0.9
382	0	0	0	15	0	60	2	10	6.2	
384	0	0	0	0	0	10	0	0	0.7	
Vaccinates	347	0	0	0	0	0	0	0	0	0
	350	15	20	10	15	0	10	12	8	11.3
	351	0	0	0	0	0	0	0	0	0
	353	0	2	0	60	5	30	10	10	10.0
	354	0	0	0	0	2	0	0	0	0.1
	356	0	0	0	0	0	0	0	0	0
	357	0	0	0	0	0	0	0	0	0
	358	0	0	0	0	0	0	0	0	0
	359	0	0	0	0	0	0	0	0	0
	362	0	0	0	0	0	0	0	0	0
	363	0	0	0	0	0	0	0	0	0
	364	0	0	0	0	0	0	0	0	0
	369	0	0	0	0	0	0	0	0	0
	370	0	0	0	0	0	0	0	0	0
	372	0	0	0	0	0	0	0	0	0
	374	0	0	0	10	0	15	2	2	2.4
	376	0	5	0	15	2	2	0	0	1.4
379	0	0	0	0	0	0	0	0	0	
380	0	2	0	0	0	0	0	0	0.1	
381	0	0	0	0	0	0	0	0	0	
383	0	0	0	0	0	0	0	0	0	
385	0	0	0	0	0	0	0	0	0	

Bold indicates animal considered affected

L= Left; R= Right

Study Type	Efficacy																		
Pertaining to	Bovine Respiratory Syncytial Virus (BRSV)																		
Study Purpose	Demonstrate Duration of Immunity (effectiveness) of the BRSV fraction																		
Product Administration	One 2 mL dose administered intranasally (Study Day 0)																		
Study Animals	Forty-four colostrum deprived calves, 5-7 days of age, divided into two groups: 22 vaccinates and 22 controls																		
Challenge Description	Challenged with aerosolized virulent BRSV virus (2 mL of challenge virus per naris), on Study Days 78 and 79 post vaccination																		
Interval observed after challenge	Calves observed daily for 8 days after challenge then lung tissue was examined.																		
Results	<p>Lung Lesion Scores:</p> <p><i>Table 1: Total lung lesions (Percent)</i></p> <table border="1"> <thead> <tr> <th>Group</th> <th>Minimum</th> <th>Q1</th> <th>Median</th> <th>Q3</th> <th>Maximum</th> </tr> </thead> <tbody> <tr> <td>Vaccinate</td> <td>0</td> <td>1</td> <td>2</td> <td>4</td> <td>7</td> </tr> <tr> <td>Control</td> <td>3</td> <td>4</td> <td>6</td> <td>9</td> <td>27</td> </tr> </tbody> </table> <p><i>Q=Quartile</i></p> <p>Raw Data is Attached</p>	Group	Minimum	Q1	Median	Q3	Maximum	Vaccinate	0	1	2	4	7	Control	3	4	6	9	27
Group	Minimum	Q1	Median	Q3	Maximum														
Vaccinate	0	1	2	4	7														
Control	3	4	6	9	27														
USDA Approval Date	June 18, 2019																		

AVERAGE LUNG LESION SCORES*

Group	Calf ID	Ave. LLS (Scorer 1 & 2)
Controls	445	3.52
	446	4.22
	451	2.89
	454	16.72
	456	4.86
	457	6.45
	459	14.70
	460	9.31
	461	8.26
	464	3.59
	466	11.98
	467	5.36
	469	7.96
	471	9.95
	472	3.53
	473	27.30
	476	4.22
479	4.83	
480	6.11	
483	9.08	
484	5.74	
487	3.86	
Vaccinates	444	4.24
	447	1.54
	448	4.02
	449	0.39
	450	1.52
	452	4.97
	453	0.59
	455	1.15
	458	0.35
	462	1.63
	463	6.03
	465	3.65
	468	6.85
	470	1.11
	474	2.13
	475	1.57
	477	3.43
478	5.47	
481	0.83	
482	2.15	
485	2.63	
486	0.36	

* Lung Lesion Score average is based on the mean of two independent scorers.

Study Type	Safety																														
Pertaining to	ALL																														
Study Purpose	Demonstrate safety of product under typical use conditions																														
Product Administration	A single 2 mL dose administered by the intranasal (IN) route																														
Study Animals	998 calves, 0 to 63 days of age, at 3 different geographical locations consisting of 665 vaccinates and 333 controls																														
Challenge Description	NA																														
Interval observed after challenge	Animals were observed daily for 14 days post vaccination.																														
Results	<p><u>Clinical Observations</u>: Numbers of animals with specific clinical observations post-vaccination:</p> <table border="1"> <thead> <tr> <th>Adverse Events (AE): VeDDRA Preferred Term (Total 998 animals in study)</th> <th>Number* Vaccinates</th> <th>Number* Control</th> </tr> </thead> <tbody> <tr> <td>NORMAL</td> <td>556</td> <td>290</td> </tr> <tr> <td>RESPIRATORY TRACT DISORDER NOS</td> <td>64</td> <td>23</td> </tr> <tr> <td>DIARRHOEA</td> <td>54</td> <td>22</td> </tr> <tr> <td>DEATH</td> <td>10</td> <td>4</td> </tr> <tr> <td>LETHARGY</td> <td>7</td> <td>4</td> </tr> <tr> <td>LAMENESS</td> <td>2</td> <td>1</td> </tr> <tr> <td>PNEUMONIA</td> <td>3</td> <td>0</td> </tr> <tr> <td>DIGESTIVE TRACT HAEMORRHAGE NOS</td> <td>1</td> <td>0</td> </tr> <tr> <td>SEPTICAEMIA</td> <td>1</td> <td>0</td> </tr> </tbody> </table> <p>NOS = Not otherwise specified</p> <p>* Subjects may have had AE in more than one VeDDRA Preferred Term and are counted once in each appropriate class. VeDDRA is the Veterinary Dictionary for Drug Regulatory Activities.</p> <p>All deaths were considered not vaccine product related as affirmed by licensee.</p>	Adverse Events (AE): VeDDRA Preferred Term (Total 998 animals in study)	Number* Vaccinates	Number* Control	NORMAL	556	290	RESPIRATORY TRACT DISORDER NOS	64	23	DIARRHOEA	54	22	DEATH	10	4	LETHARGY	7	4	LAMENESS	2	1	PNEUMONIA	3	0	DIGESTIVE TRACT HAEMORRHAGE NOS	1	0	SEPTICAEMIA	1	0
Adverse Events (AE): VeDDRA Preferred Term (Total 998 animals in study)	Number* Vaccinates	Number* Control																													
NORMAL	556	290																													
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DEATH	10	4																													
LETHARGY	7	4																													
LAMENESS	2	1																													
PNEUMONIA	3	0																													
DIGESTIVE TRACT HAEMORRHAGE NOS	1	0																													
SEPTICAEMIA	1	0																													
USDA Approval Date	July 5, 2019																														

Study Type	Safety
Pertaining to	All fractions
Study Purpose	Safety by intranasal administration to pregnant cows and calves nursing pregnant cows
Product Administration	
Study Animals	
Challenge Description	
Interval observed after challenge	
Results	Scientific data were evaluated by USDA-APHIS prior to product licensure and met regulatory standards for acceptance at the time of submission.