QUANTIFICATION PROTOCOL FOR REDUCING DAYS ON FEED OF CATTLE:

ABRIDGED

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Submitted to:

Alberta Environment

and

Alberta Agriculture, Food and Rural Development

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Acknowledgements

This protocol is largely based on the *Quantification Protocol for Including Edible Oils in Cattle Feeding Regimes, Version 1*, dated September 2007 and the *Quantification Protocol for Reducing Slaughter Age of Cattle, Version* 1, dated September 2007. These documents are approved Alberta Offset System protocols having gone through a round of technical review, a broader round of stakeholder review through April and May, 2007, and a public comment period.

Disclaimer

The following document presents an abridged version of the Reducing Days on Feed of Cattle protocol prepared for Alberta Environment and Alberta Agriculture, Food and Rural Development which has completed an initial round of technical review. This document has been prepared as a means of supporting a broader stakeholder consultation process. As such, this document should not be used as a quantification protocol.

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1.0 Project and Methodology Scope and Description

The opportunity for generating carbon offsets with this protocol arises from the direct and indirect reductions of greenhouse gas (GHG) emissions from reducing the days of feed for cattle being finished on feed lots.

This quantification protocol is written for the beef farm operator or project developer. Some familiarity with, or general understanding of, the operation of a beef farm and associated practices is expected.

This protocol quantifies enteric methane emissions from cattle; and emissions from manure handling, storage and application during the period the animal is being finished on feed lots. **FIGURE 1.1** offers a project element life cycle chart for a typical project.

The Days on Feed Protocol does not prescribe the genetics of the animals or feeding practices for beef production. Rather, this protocol serves as a generic 'recipe' for project proponents to follow in order to meet the measurement, monitoring and GHG quantification requirements. The Days on Feed Protocol quantifies emissions reductions on the basis of the reduction of days required for finishing for groupings of cattle. Records with respect to the number of cattle, incoming and outgoing weights, diets (quantity and composition), and days on feed, among others, are required.

In Canada, beef cattle are slaughtered within a range of between 14 and 21 months. During a finishing period of this life cycle, the cattle may spend time on a feedlot. The baseline condition for projects applying this protocol is defined as the operating conditions at the project farm prior to the change in practises that resulted in the reduction in days on feed. The baseline condition would be defined as the average number of days on feed for animals within weight groupings at the project proponent's beef production operation for the three years prior to project implementation. **FIGURE 1.2** offers an element life cycle chart for a typical baseline configuration.

The boundary of the Days on Feed Protocol includes the feedlot barn where the cattle are finished, the facility where manure is stored and the land where the manure is spread.

To demonstrate that a project meets the requirements under this Protocol, the project developer must supply sufficient evidence to demonstrate that:

1. All farms in the project are currently storing manure and applying manure or custom applying manure to land as confirmed by an affirmation from the project developer;
2. All farms in the project can demonstrate a change in practice in terms of the number of days their cattle were on feed as confirmed by operational records; and
3. The quantification of reductions achieved by the project is based on actual measurement and monitoring (except where indicated in this protocol) as indicated by the proper application of this protocol.

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Flexibility in applying the quantification protocol is provided to project developers in two ways:

1. Farms that do not have three years of baseline data as per the days on feed for cattle of specific incoming weights may establish a baseline condition based on a combination of available data and industry practise in their region or operation;
2. Farms that including edible oils (between 4% and 6%) within some or all of the feeding periods during finishing may also apply the Edible Oils protocol in parallel with this protocol should it be applicable;
3. Farms where the incoming weights and days on feed vary across groups of animals, these animals can be grouped in discreet units and tracked individually. In this case, the baseline condition may need to be calculated relative to the groups of animals with similar characteristics of incoming and finishing weights; and
4. Site specific emission factors may be substituted for the generic emission factors indicated in this protocol document. The methodology for generation of these emission factors must ensure reasonable accuracy.

If applicable, the proponent must indicate and justify why flexibility provisions have been used.

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FIGURE 1.1: Project Element Life Cycle Chart

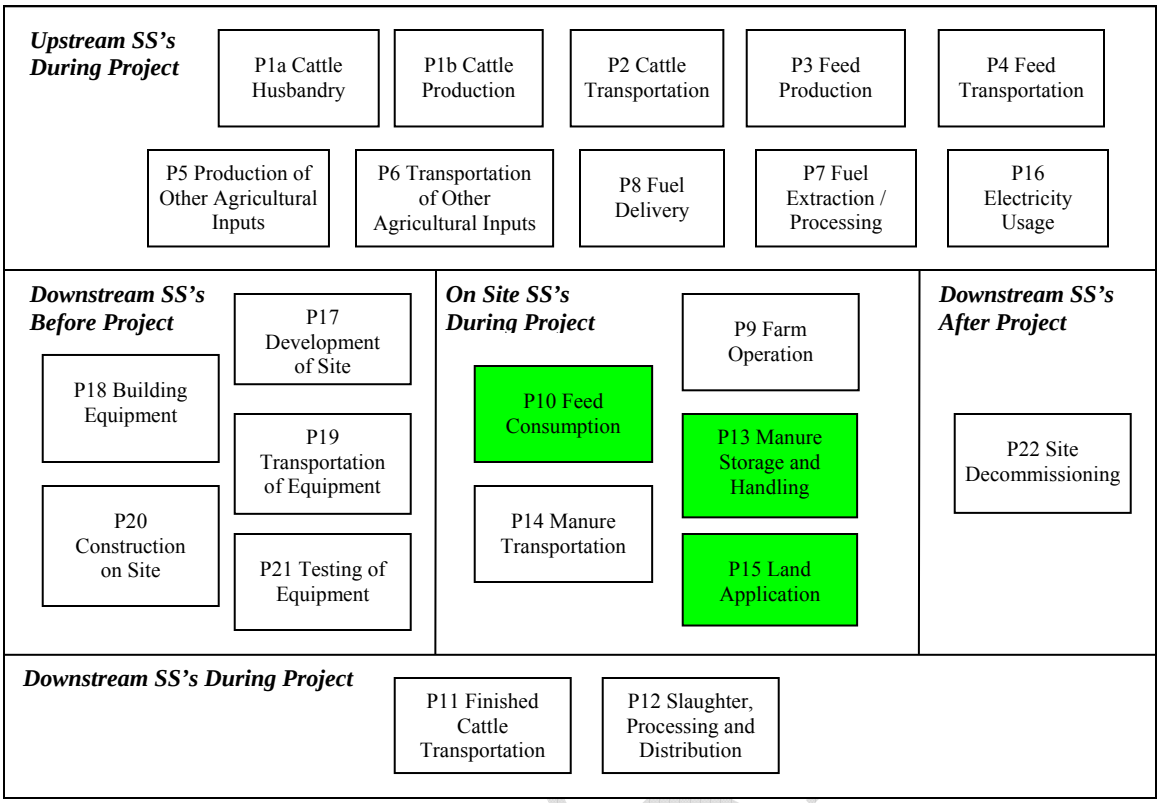
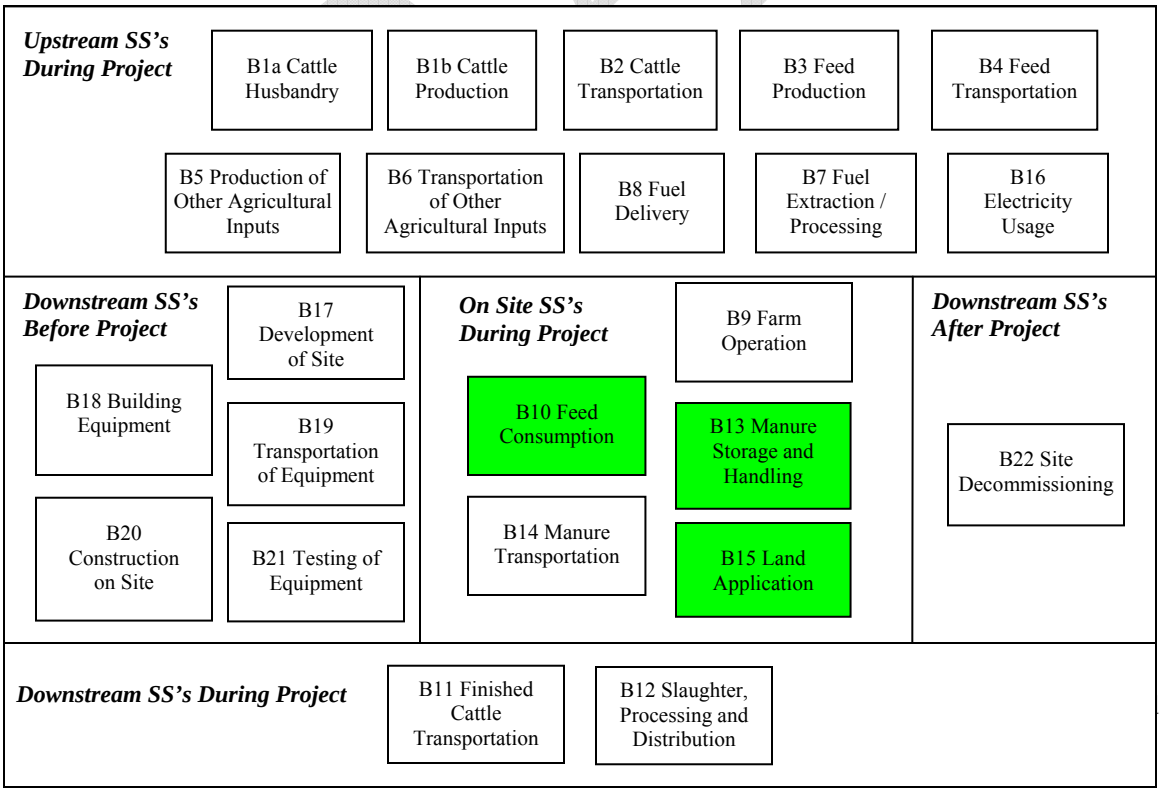


FIGURE 1.2: Baseline Element Life Cycle Chart



* Sources, sinks and reservoirs selected for measurement and monitoring under this protocol are highlighted

2.0 Quantification of Identified Sources, Sinks and Reservoirs

Quantification of the reductions, removals and reversals for the sources, sinks and reservoirs selected for measurement and monitoring under this protocol will be completed using the methodologies outlined in **TABLE 2.1**, below. These calculation methodologies serve to complete the following three equations for calculating the emission reductions from the comparison of the baseline and project conditions.

$$\text{Emission Reduction} = \text{Emissions}_{\text{Baseline}} - \text{Emissions}_{\text{Project}}$$

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Cattle}} + \text{Emissions}_{\text{Manure}}$$

$$\text{Emissions}_{\text{Project}} = \text{Emissions}_{\text{Cattle}} + \text{Emissions}_{\text{Manure}}$$

Where:

$\text{Emissions}_{\text{Baseline}}$ = sum of the emissions under the baseline condition.
- $\text{Emissions}_{\text{Cattle}}$ = emissions under SS B10 Feed Consumption
- $\text{Emissions}_{\text{Manure}}$ = emissions under SS B13 Manure Storage and Handling and B15 land Application

$\text{Emissions}_{\text{Project}}$ = sum of the emissions under the project condition.
- $\text{Emissions}_{\text{Cattle}}$ = emissions under SS P10 Feed Consumption
- $\text{Emissions}_{\text{Manure}}$ = emissions under SS P13 Manure Storage and Handling and P15 land Application

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TABLE 1.1: Quantification Procedures

1.0 Project/ Baseline SS	2. Parameter / Variable	3. Unit
Project SS's		
P10 Feed Consumption	$Emissions_{Cattle} = \Sigma (Number_{Production\ i} * DOF_{i} * DMI_{i} * GE_{Diet} * (EF_{Enteric\ i} / 100\%) / EC_{Methane})$	
	Enteric Emissions from Cattle for each feed regime within each weight grouping / $Emissions_{Cattle}$	kg CH_4 / day / per weight grouping
	Number of Cattle in Grouping i / $Number_{Production\ i}$	Head
	Days on Feed for Each Feed Regime for Cattle in Grouping i / DOF_{i}	Days
	Dry Matter Intake for Each Feed Regime for Cattle in Grouping i / DMI_{i}	$kg_{dry\ matter}$ / head / day
	Default value: Gross energy content (GE) of the diet GE_{Diet}	$MJ / kg_{dry\ matter}$
	Emission Factor for Enteric Emissions for Each Feed Regime in Grouping i / $EF_{Enteric\ i}$	%
	Energy Content of Methane / $EC_{Methane}$	$MJ / kg_{methane}$
P13 Manure Storage and P15 Land Application	$VS_{i} = [(DMI_{i} * GE_{Diet} * (1 – (TDN_{i} / 100\%))) + (UE * DMI_{I} * GE_{Diet})] * ((1 – (Ash / 100\%)) / GE_{Diet})$	
	Daily Volatile Solid Excreted for Livestock in Grouping i and Each Feed Regime / VS_{i}	kg / head / day
	Dry Matter Intake for Each Feed Regime for Cattle in Grouping i / DMI_{i}	$kg_{dry\ matter}$ / head / day
	Default value: Gross energy content (GE) of the diet GE_{Diet}	$MJ / kg_{dry\ matter}$
	Total Digestible Nutrients for Each Feed Regime for Cattle in Grouping i / TDN_{i}	%
	Urinary Energy / UE	-
	Ash Content of Manure Calculated as a Fraction of the Dry Matter Feed Intake for Cattle / Ash	%
	$Emissions_{Manure\ CH4} = \Sigma (Number_{Production\ i} * DOF_{i} * VS_{i} * Bo * \rho_{Methane} * (MCF / 100\%))$	
	Methane Emissions from Manure Handling, Storage and Land Application for each feed regime within each weight grouping / $Emissions_{Manure\ CH4}$	kg CH_4 / day / per weight grouping
	Number of Cattle in Grouping i / $Number_{Production\ i}$	Head
	Days on Feed for Each Feed Regime for Cattle in Grouping i / DOF_{i}	days
	Maximum Methane Producing Capacity for Manure Produced / Bo	m^3_{CH4} / $kg_{VS\ Excreted}$
	Density of Methane / $\rho_{Methane}$	m^3 / kg
	Methane Conversion Factor / MCF	%
	$Nitrogen_{Excreted\ i} = DMI_{i} * (CP_{i} / 100\%) / CF_{Protein} * (1 – Nitrogen_{Retention})$	
	Nitrogen Excreted by the Livestock in Grouping i / $Nitrogen_{Excreted\ i}$	kg / head / day
	Dry Matter Intake for Each Feed Regime for Cattle in Grouping i / DMI_{i}	$kg_{dry\ matter}$ / head / day
	Percent Crude Protein in Diet for Each Feed Regime in Cattle in Grouping i / CP_{i}	%
	Conversion from Mass of Dietary Protein to Mass of Dietary Nitrogen	$kg_{feed\ protein}$ / $kg_{nitrogen}$
	Fraction of Annual Nitrogen Intake Retained / $Nitrogen_{Retention}$	$kg_{retained}$ / kg_{intake}
	$Emissions_{Direct\ Nitrous\ Oxide} = \Sigma (Number_{Production\ i} * DOF_{i} * Nitrogen_{Excreted\ I} * CF_{Manure}) * 44 / 28$	
	Direct Emissions of Nitrous Oxide from Manure for each feed regime within each weight grouping / $Emissions_{Direct\ Nitrous\ Oxide}$	kg N_2O / day / per weight grouping

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	CF_{Manure}	-
	$Emissions_{Direct\ Storage} = \Sigma\ (Number_{Production\ i} * DOF_{i} * Nitrogen_{Excreted\ i} * Frac_{Storage} * EF_{Storage}) * 44 / 28$	
	Direct Emissions of Nitrous Oxide from Manure Storage / $Emissions_{Direct\ Storage}$	kg N_2O / day / per weight grouping
	$Frac_{Storage}$	-
	$EF_{Storage}$	kg $_{N2O-N}$ / kg $_{Nitrogen\ Excreted}$
	$Emissions_{Indirect\ Volatization} = \Sigma\ (Number_{Production\ i} * DOF_{i} * Nitrogen_{Excreted\ i} * Frac_{Volatization} * EF_{Volatization}) * 44 / 28$	
	Indirect Emissions of Nitrous Oxide from Volatization for each feed regime within each weight grouping / $Emissions_{Indirect\ Volatization}$	kg N_2O / day / per weight grouping
	$Frac_{Volatization}$	-
	$EF_{Volatization}$	kg $_{N2O-N}$ / kg $_{Nitrogen\ Excreted}$
	$Emissions_{Indirect\ Volatization} = \Sigma\ (Number_{Production\ i} * DOF_{i} * Nitrogen_{Excreted\ i} * Frac_{Leach} * EF_{Leach}) * 44 / 28$	
	Indirect Emissions of Nitrous Oxide from Leaching for each feed regime within each weight grouping / $Emissions_{Indirect\ Leach}$	kg N_2O / day / per weight grouping
	$Frac_{Leach}$	-
	EF_{Leach}	kg $_{N2O-N}$ / kg $_{Nitrogen\ Excreted}$
Baseline SS's		
B10 Feed Consumption	$Emissions_{Cattle} = \Sigma\ (Number_{Production\ i} * DOF * DMI_{i} * GE_{Diet} * (EF_{Enteric\ i} / 100\%) / EC_{Methane})$	
	Enteric Emissions from Cattle for each feed regime within each weight grouping / $Emissions_{Cattle}$	kg CH_4 / day / per weight grouping
	Number of Cattle in Grouping i / $Number_{Production\ i}$	Head
	Days on Feed for Each Feed Regime for Cattle in Grouping i / DOF_{i}	Days
	Dry Matter Intake for Each Feed Regime for Cattle in Grouping i / DMI_{i}	kg $_{dry\ matter}$ / head / day
	Default value: Gross energy content (GE) of the diet GE_{Diet}	MJ / kg $_{dry\ matter}$
	Emission Factor for Enteric Emissions for Each Feed Regime in Grouping i / $EF_{Enteric\ i}$	%
	Energy Content of Methane / $EC_{Methane}$	MJ / kg $_{methane}$
B13 Manure Storage and B15 Land Application	$VS_{i} = [(DMI_{i} * GE_{Diet} * (1 – (TDN_{i} / 100\%))) + (UE * DMI_{I} * GE_{Diet})] * ((1 – (Ash / 100\%)) / GE_{Diet})$	
	Daily Volatile Solid Excreted for Livestock in Grouping i and Each Feed Regime / VS_{i}	kg / head / day
	Dry Matter Intake for Each Feed Regime for Cattle in Grouping i / DMI_{i}	kg $_{dry\ matter}$ / head / day
	Default value: Gross energy content (GE) of the diet GE_{Diet}	MJ / kg $_{dry\ matter}$
	Total Digestible Nutrients for Each Feed Regime for Cattle in Grouping i / TDN_{i}	%
	Urinary Energy / UE	-
	Ash Content of Manure Calculated as a Fraction of the Dry Matter Feed Intake for Cattle / Ash	%
	$Emissions_{Manure\ CH4} = \Sigma\Sigma\ (Number_{Production\ i} * DOF_{i} * VS_{i} * Bo * \rho_{Methane} * (MCF / 100\%))$	

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	Methane Emissions from Manure Handling, Storage and Land Application for each feed regime within each weight grouping / Emissions $_{Manure\ CH4}$	kg CH_4 / day / per weight grouping
	Number of Cattle in Grouping i / Number $_{Production\ i}$	Head
	Days on Feed for Each Feed Regime for Cattle in Grouping i / DOF $_i$	Days
	Maximum Methane Producing Capacity for Manure Produced / Bo	m^3 $_{CH4}$ / kg $_{VS\ Excreted}$
	Density of Methane / ρ $_{Methane}$	m^3 / kg
	Methane Conversion Factor / MCF	%
	Nitrogen $_{Excreted\ i}$ = DMI $_i$ * (CP $_i$ / 100%) / CF $_{Protein}$ * (1 – Nitrogen $_{Retention}$)	
	Nitrogen Excreted by the Livestock in Grouping i / Nitrogen $_{Excreted\ i}$	kg / head / day
	Dry Matter Intake for Each Feed Regime for Cattle in Grouping i / DMI $_i$	kg $_{dry\ matter}$ / head / day
	Percent Crude Protein in Diet for Each Feed Regime in Cattle in Grouping i / CP $_i$	%
	Conversion from Mass of Dietary Protein to Mass of Dietary Nitrogen	kg $_{feed\ protein}$ / kg $_{nitrogen}$
	Fraction of Annual Nitrogen Intake Retained / Nitrogen $_{Retention}$	kg $_{retained}$ / kg $_{intake}$
	Emissions $_{Direct\ Nitrous\ Oxide}$ = ΣΣ (Number $_{Production\ i}$ * DOF $_i$ * Nitrogen $_{Excreted\ i}$ * CF $_{Manure}$) * 44 / 28	
	Direct Emissions of Nitrous Oxide from Manure for each feed regime within each weight grouping / Emissions $_{Direct\ Nitrous\ Oxide}$	Kg N_2O / day / per weight grouping
	CF $_{Manure}$	-
	Emissions $_{Direct\ Storage}$ = ΣΣ (Number $_{Production\ i}$ * DOF $_i$ * Nitrogen $_{Excreted\ i}$ * Frac $_{Storage}$ * EF $_{Storage}$) * 44 / 28	
	Direct Emissions of Nitrous Oxide from Manure Storage for each feed regime within each weight grouping / Emissions $_{Direct\ Storage}$	kg N_2O / day / per weight grouping
	Frac $_{Storage}$	-
	EF $_{Storage}$	kg $_{N2O\text{-}N}$ / kg $_{Nitrogen\ Excreted}$
	Emissions $_{Indirect\ Volatization}$ = ΣΣ (Number $_{Production\ i}$ * DOF $_i$ * Nitrogen $_{Excreted\ i}$ * Frac $_{Volatizaton}$ * EF $_{Volatization}$) * 44 / 28	
	Indirect Emissions of Nitrous Oxide from Volatization for each feed regime within each weight grouping / Emissions $_{Indirect\ Volatization}$	kg N_2O / day / per weight grouping
	Frac $_{Volatization}$	-
	EF $_{Volatization}$	kg $_{N2O\text{-}N}$ / kg $_{Nitrogen\ Excreted}$
	Emissions $_{Indirect\ Leach}$ = ΣΣ (Number $_{Production\ i}$ * DOF $_i$ * Nitrogen $_{Excreted\ i}$ * Frac $_{Leach}$ * EF $_{Leach}$) * 44 / 28	
	Indirect Emissions of Nitrous Oxide from Leaching for each feed regime within each weight grouping / Emissions $_{Indirect\ Leach}$	kg N_2O / day / per weight grouping
	Frac $_{Leach}$	-
	EF $_{Leach}$	kg $_{N2O\text{-}N}$ / kg $_{Nitrogen\ Excreted}$

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APPENDIX A: Glossary of New Terms

The following definitions are critical to the appropriate interpretation of this quantification protocol.

Concentrates:	A broad classification of feedstuffs which are high in energy and low in crude fibre (<18% CF).
Edible Oils:	Oils derived from plants that are composed primarily of triglycerides. Although many different parts of plants may yield oil, in commercial practice oil is extracted primarily from the seeds of oilseed plants. Whole seeds can be applied as a feed ingredient so long as the oil content is calculated on a dry matter basis to achieve the 4 to 6% content in the diet.
Enteric Emissions:	Emissions of methane from the cattle as part of the digestion of the feed materials.
Land Application:	The beneficial use of the agricultural material and/or digestate applied to cropland based upon crop needs and the composition of agricultural material as a source of soil amendment and/or fertility.
Weight Groupings:	Animals are considered to be in specific weight groupings based on incoming and outgoing weights. Within a specified class, each of the ranges of incoming and outgoing weights must be within 25 kg intervals. As an example, animals coming on feed between 225 and 250 kgs, leaving between 600 and 625 may be a weight class for a given project site. However, another project site may use an incoming weight range of 210 to 235 kgs, and outgoing weight range of 575 to 600kgs as a weight class.

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