

LOW STRESS SLAUGHTER EQUIPMENT FOR LAMBS AND CALVES

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Thirty-six Holstein bull calves, 12 each of 8, 12 and 16 weeks of age; and thirty-two lambs, 16 lightweight (33.6 kg to 40.9 kg) and 16 heavyweight (45.5 kg to 58.6 kg), were divided and randomly assigned to two methods of pre-slaughter restraint (shackled or yoked) and two methods of exsanguination (stunned and non-stunned). Heart rate, respiration rate and rectal temperature were measured pre-slaughter and blood volume, bleed-out rate, carcass pH, cooking loss and Warner-Bratzler shear force were determined post-mortem as indicators of stress levels and their effects. A stress index (CMCSI) was developed as a single measure of the degree of stress imposed on these calves and lambs.

A double-rail, low stress system for conveying, restraining and presenting calves and lambs for slaughter was developed and tested for practicality, efficiency, humaneness and overall acceptability by the industry. A significant ( $P < .01$ ) reduction in stress (CMCSI) was noted for this double-rail system when compared with the conventional method of slaughtering calves and lambs. This low-stress system is designed for a capacity of 200 calves per hour or 400 lambs per hour. The rails are conveyorized and have an adjustable speed of 12.19 cms. to 30.48 cms. per second. The basic unit is 13.36 meters long and will accommodate 5 to 7 calves or lambs at one time. A series of hold-down and neck-stretcher frames have been developed to properly restrain and present calves or lambs for stunning and/or slaughter. A ten-second interval between exsanguination and shackling permits complete comatization and principal bleed-out to occur before elevating the animal. Automatic shackling may be installed.

Age, weight, method of restraint and immobilization were shown to have individual and/or interaction effects on the various stress components measured and on the stress index calculated for the calves and lambs tested under the conditions of this study. The higher levels of stress were found to influence unfavorably the cooking loss and tenderness of the meat from these carcasses.

L'OUTILLAGE POUR L'ABATTAGE DE TENSION BASSE POUR LES AGNEAUX ET LES VEAUX

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Trente-six veaux mâles de la race Holstein, 12 de 8, 12, et 16 semaines d'âge; et trente-deux agneaux, 16 de poids léger (33.6 kg à 40.9 kg) et 16 de poids lourd (45.5 kg à 58.6 kg), étaient divisés et assignés au hasard aux deux méthodes de contrainte pré-abattage (entravée ou mise au joug) et aux deux méthodes de l'exsanguination (étourdie ou non-étourdie). La fréquence de pouls, la fréquence de la respiration, et la température rectale étaient mesurées avant l'abattage et le volume de sang, la fréquence de la saignée, le pH de la carcasse, la perte pendant la cuisson et la force "Warner-Bratzler" étaient déterminés après la mort comme indicateurs des niveaux de tension et leurs effets. Un indice de tension (CMCSI) était développé comme seule mesure du degré de tension imposé sur ces veaux et sur ces agneaux.

Un système à double-rail de tension basse pour transporter, retenir, et présenter les veaux et les agneaux pour l'abattage était développé et testé pour sa nature pratique, son efficacité, son humanité et son acceptabilité générale par l'industrie. Une réduction significative ( $P < .01$ ) de la tension (CMCSI) était observée pour ce système à double-rail quand on le compare avec la méthode conventionnelle d'abattre les veaux et les agneaux. Ce système de tension basse est destiné à une capacité de 200 veaux à l'heure ou 400 agneaux à l'heure. Les rails sont construits comme tapis roulant et ont une vitesse réglable de 12.19 cms. à 30.48 cms. par seconde. L'appareil est 13.36 mètres de long et tiendra de 5 à 7 veaux ou agneaux à la fois. Une série de châssis pour tenir les animaux et pour étendre leurs nuques ont été développés pour retenir et pour présenter comme il faut les veaux et les agneaux pour l'étourdissement et/ou l'abattage. Un intervalle de dix secondes entre l'exsanguination et l'action de l'entraver permet la comatisation complète et la saignée principale de se produire avant l'élévation de l'animal. On peut installer un appareil pour entraver l'animal de façon automatique.

On a démontré que l'âge, le poids, la méthode de contrainte et l'immobilisation avaient des effets individuels et/ou des actions réciproques sur les différents composants de tension mesurés et sur l'indice de tension calculé pour les veaux et pour les agneaux testés sous les conditions de cette étude. On a trouvé que les plus hauts niveaux de tension avaient une influence défavorable sur la perte pendant la cuisson et la tendreté de la viande issue de ces carcasses.

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### NIEDRIGDRANGSTANDSCHLACHTGERÄTE FÜR LÄMMER UND KÄLBER

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Sechsunddreißig Holsteiner Stierkälber, je 12, 8, 12 und 16 Wochen alt; und zweiunddreißig Lämmer, 16 Leichtgewicht (33,6 kg bis 40,9 kg) und 16 Schwergewicht (45,5 kg bis 58,6 kg), wurden eingeteilt und unregelmäßig zwei Methoden Vorschlachtenzügelung (gefesselt und angespannt) und zwei Methoden Exsanguination (betäubt und unbetäubt) zugewiesen. Pulsschlag, Atemmaß und Rektaltemperatur wurden vor dem Schlachten aufgeschrieben; und Blutgehalt, Verblutungsmaß, pH der Körper, Kochverlust und Warner-Bratzler Schubkraft wurden nach dem Tode als Anzeiger der Drangstände und ihrer Wirkung festgestellt. Ein Drangindex (CMCSI) wurde als alleinstehendes Maß des diesen Lämmern und Kälbern auferlegten Drangstandes entwickelt.

Ein Doppelgleis-Niedrigdrangsysteem für das Transportieren, Zügeln und Überreichen der Kälber und Lämmer für das Schlachten wurde entwickelt und für die Anwendbarkeit, Leistungsfähigkeit, Menschlichkeit und allgemeine Annehmbarkeit in der Industrie untersucht. Eine bedeutende ( $P < 0,1$ ) Verminderung des Dranges (CMCSI) wurde für dieses Doppelbahnsystem festgestellt, wenn es mit der konventionellen Methode des Lämmer- und Kälberschlachtens verglichen wurde. Dieses Niedrigdrangsysteem ist für eine Kapazität von 200 Kälbern oder 400 Lämmern pro Stunde gedacht. Die Bahnen sind am laufenden Band und haben eine regulierbare Geschwindigkeit von 12,19 cms. bis 30,48 cms. pro Sekunde. Das grundlegende Gerät ist 13,36 Meter lang und wird 5 bis 7 Kälber oder Lämmer zu einer Zeit unterbringen. Eine Reihe von Niederhalte- und Halsstreckgerüsten sind entwickelt worden, um die Kälber und Lämmer richtig zu zügeln und zum Betäuben bzw. Schlachten zu überreichen. Eine 10 Sekunde Pause zwischen Exsanguination und Fesseln ermöglicht totale Schlafsucht und allgemeine Verblutung vor dem Hochheben des Tieres. Automatische Fesselung kann eingebaut werden.

Es zeigt sich, daß Alter, Gewicht und Methode der Zügelung und des Festhaltens individuelle bzw. wechselwirkende Ergebnisse auf die verschiedenen Drangkomponenten und den Drangindex, die für die unter die Voraussetzungen dieser Arbeit untersuchten Kälber und Lämmer kalkuliert werden. Es stellte sich heraus, daß die höheren Drangebenen den Kochverlust und die Zartheit des Fleisches dieser Körper unvorteilhaft beeinflussen.

### МЕТОД ЗАБОЯ ТЕЛЯТ И ЯГНЯТ ПРИ НИЗКОМ НАПРЯЖЕНИИ / СТРЕССЕ /

ДОНАЛЬД КИНСМЕН, РАЛЬФ ПРИНС, УОЛТЕР ДЖАЛДЖЕР ЮН. и РУДИ ВЕСТЕРВЕЛЬТ.

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Тридцать шесть телят Уолстин / каждая дюжина из них 8, 12 и 16 недель от рода / и тридцать два ягненка / 16 небольшого веса, от 33,6 кг до 40,9 кг, и 16 большего от 45,5 кг до 58,6 кг / были разделены и на выбор подвергались двум методам фиксации перед забоем / стреноживание и заключение под ярмо / и д'ум методам обескровливания / при воздействии тока и без него /. Показатели сердцебиения, дыхания и внутримышечной температуры измерялись перед забоем животных; объем крови, показатель утечки крови, pH туши, утечка при обработке и крепость обработки шкуры по методу Уорнер-Брэтцлер определялись после забоя и служили показателями уровня напряжения и их воздействий. Показатель напряжения /CMCSI / был принят в качестве единственной меры степени напряжения, воздействовавшего на этих телят и ягнят.

Система двойного ограждения и низкого напряжения применялась для подготовки телят и ягнят к забою и испытывалась на ее практичность, эффективность, человечность и всевозможной пригодности в производстве. При системе двойного ограждения замечалось значительное /  $P < 0,1$  / уменьшение напряжения по сравнению с обычным методом забоя телят и ягнят. Система низкого напряжения предполагает пропуск 200 телят и 400 ягнят в час. Система двойного ограждения снабжена конвейером, который движется с достаточной скоростью - от 12,19 см до 30,48 см в сек. Основное деление конвейера длиной 13,35 м позволяет расположить на нем от 5 до 7 телят или ягнят в одно и то же время. Применилась серия рамочных стреног фиксирующих и закрепляющих шею животного, чтобы изолировать и подготовить его к оглушению / шоку / или забою. Интервал в 10 сек. между обескровливанием и стреноживанием обеспечивает полную пассивность и основную утечку крови до того, как животное поднимают. Возможно автомат. стреноживание.

Как показано, возраст, вес, метод удерживания и обеспечения неподвижности по-разному и индивидуально воздействуют на различные составные части напряжения и его показатели, определенные на телятах и ягнятах, использованных для данного изучения. Более высокие уровни напряжения, как оказалось, неблагоприятно воздействуют на утечку при обработке и нежность мяса у этих туш.

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### INTRODUCTION

Approximately eleven million lambs and three million calves are processed for meat in the United States annually. Of these numbers about one million lambs and 500,000 calves are slaughtered by Kosher procedures. Concern has been expressed relative to the stress to which these meat animals are exposed while still conscious during their restraining, shackling, hoisting and positioning for slaughter. The degree of stress has been measured by Westervelt *et al.* (1974) and an index developed to compare stress under differing slaughter conditions and at various steps in the sequence. Other scientists (Briskey, 1964; Judge *et al.*, 1968; and Kropf *et al.*, 1973) have investigated animal stress under long-term and production conditions as to the effects of stress on meat properties. However, very little research has dealt with the influence of stress at time of and during slaughter on the ultimate product. From both a humane and a meat quality standpoint there is a real need for further research in this vital area of concern.

### EXPERIMENTAL PROCEDURES

This study was conducted to determine a method of comfortably and efficiently presenting calves and lambs for slaughter that would meet production line requirements yet impose a minimum of stress on the animals for either Kosher or non-Kosher procedures.

Of the many ideas and devices examined it ultimately evolved that both species showed greatest natural comfort and least stress when suspended in normal attitude on two rails (Figure 1) regardless of method of positioning and duration of exposure. This pattern then became the basic design for more sophisticated development of a unit that would lend itself to practical use in plants of varying production speeds, animal sizes and single or multi-species operations. Stress comparisons were conducted throughout the study to ascertain the effectiveness of the developing systems toward meeting all criteria.

Thirty-six Holstein bull calves, 12 each of 8, 12 and 16 weeks of age; and thirty-two lambs, 16 lightweight (33.6 kg to 40.9 kg) and 16 heavyweight (45.5 kg. to 58.6 kg.), were divided and randomly assigned to two methods of preslaughter restraint (shackled or yoked) and two methods of exsanguination (stunned and non-stunned). Heart rate, respiration rate and rectal temperature were measured preslaughter and blood volume, bleed-out rate, carcass pH, cooking loss and Warner-Bratzler shear force were determined post-mortem as indicators of stress levels and their effects. A stress index, the Connecticut Multi-Component Stress Index (CMCSI), was developed as a single measure of the degree of stress imposed on these calves and lambs.

### RESULTS AND DISCUSSION

Once the double rail system (Figure 1) was established as a feasible method of presenting calves and lambs for slaughter several parameters were evaluated. Initially, a small, air-operated combination pen and hoisting device employing the double rail was developed (Figure 2) to examine the level for stress, workability and adaptability to small and/or existing operations. A significant ( $P < .01$ ) reduction in stress was demonstrated (Westervelt *et al.*, 1974) for the double rail system compared with conventional methods. Once proven feasible and equally adaptable to both species a double rail conveyor with a capacity of 200 calves per hour or 400 lambs per hour was constructed (Figure 3). Each rail is 4.12 cms wide with a gap of 7.62 cms. between the two rails; the rails are 76.20 cms. above the floor and are conveyorized within a chute 40.64 cms. wide. The conveyor travels at an adjustable rate of 12.19 cms. to 30.48 cms. per second and may be stopped at any point. The basic conveyor is 13.36 meters long and will accommodate 5 to 7 calves or lambs at one time.

Simultaneously with the evolution of the double rail system a series of hold-down, neck-stretcher frames were developed to properly restrain and present calves and lambs for stunning and/or slaughter (Figure 4). Ten seconds has been determined as adequate time from exsanguination to shackling and hoisting in that the animal is fully comatized in that period (Nangeroni and Kennett, 1963). Therefore, the conveyor and restrainer-holder were synchronized to allow orderly transition of the animal from the conveyor to the rail in that time lapse. The restraining frame, guided by tracks in the side of the chute, is applied as the animal comes to rest on the conveyor and travels the length of the conveyor with the animal. It is returned for reuse following transfer of the shackled animal to the overhead rail.

Automatic shackling of calves and lambs from this system has also been investigated but not perfected as of this report. It does appear practical, however, utilizing approximately 30 volts AC postexsanguination to immobilize and index the hind legs for mechanical, automatic shackling.

Age, weight, method of restraint and immobilization were shown to have individual and/or interaction effects on the various stress components measured and on the stress index (Figure 5) calculated for the calves and lambs tested under the conditions of this study. The higher levels of stress were found to influence unfavorably the cooking loss and tenderness of the meat from these carcasses.

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Several methods of enticing animals on to a moving conveyor were investigated. These included a curved chute to the point of entry, a "wobbly wedge" to spread the legs as the animals approached the conveyor, a metal, slippery slide onto the conveyor and darkening the general transition area. Other methods of enticement are being explored such as sound, odor, sight and example as well as crowding gates.

## CONCLUSIONS

A double rail conveyorized system for presenting calves and lambs for slaughter in an efficient, practical, rapid and humane manner has been developed. This system includes special procedures and equipment for transfer, restraint, presentation, exsanguination and shackling at a maximum rate of 200 calves or 400 lambs per hour. A significant ( $P < .01$ ) reduction in stress was noted for the double rail system when compared to the conventional method of dispatching calves and lambs. Patents are pending on a number of features of this system which will be available royalty-free to the industry through the courtesy of the Council for Livestock Protection, Inc. (40 Wall Street, Room 5300, New York City, New York 10005) which supported this research to a major extent.

## SELECTED REFERENCES

- Briskey, E. J. 1964. Etiological Status and Associated Studies of Pale, Soft, Exudative Porcine Musculature. Advances in Food Research. 13:89-178
- Judge, M. D., J. C. Forrest, J. D. Sink and E. J. Briskey. 1968. Endocrine Related Stress Responses and Muscle Properties of Swine. J. Anim. Sci. 27:1247-1253.
- Kropf, D. H., D. R. Ames and L. H. Arehart. 1973. Effect of Sound Stress on Lamb Muscle Color. J. Anim. Sci. 37:365. (Abst.)
- Nangeroni, L. L. and P. D. Kennett. 1963. An Electroencephalographic Study of the Effect of Shechita Slaughter on Cortical Function in Ruminants. Report, Dept. of Physiology, New York State Veterinary College, Cornell University, Ithaca, New York 14850
- Westervelt, R. G., D. M. Kinsman, R. P. Prince and W. Giger, Jr. 1974. Physiological Stress Measurement in Calves and Lambs. J. Anim. Sci. 39:177 (Abst.)

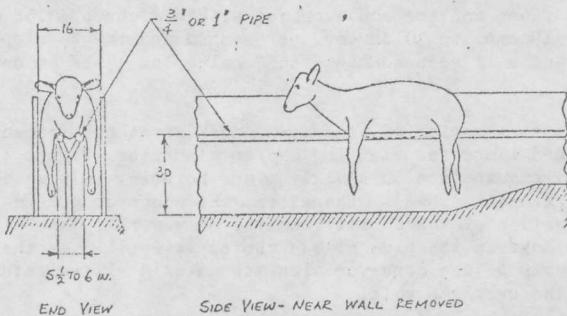


FIG. 1. DOUBLE RAIL SUPPORT SYSTEM

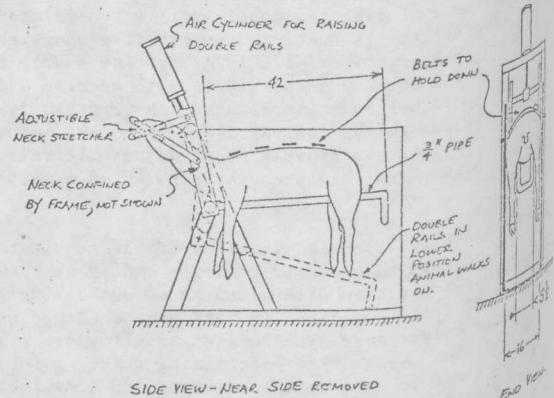


FIG. 2. AIR OPERATED DOUBLE RAIL PEN  
ANIMAL WALKS INTO PEN, WITH DOUBLE RAILS IN LOWER POSITION.  
AIR CYLINDER RAISES THE DOUBLE RAILS PRIOR TO SLAUGHTER.

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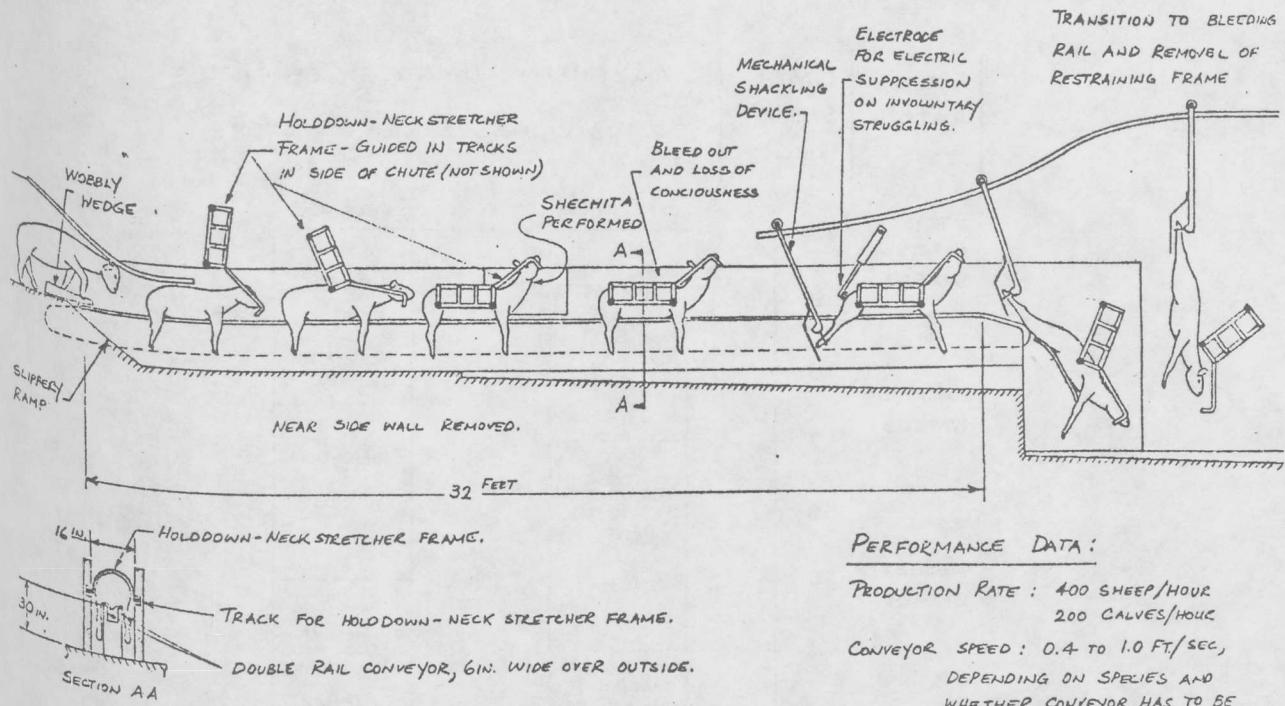


FIG. 3. DOUBLE RAIL PRODUCTION LINE (PROPOSED)

PERFORMANCE DATA:

PRODUCTION RATE: 400 SHEEP/HOUR  
200 CALVES/HOUR  
CONVEYOR SPEED: 0.4 TO 1.0 FT./SEC,  
DEPENDING ON SPECIES AND  
WHETHER CONVEYOR HAS TO BE  
STOPPED FOR SHECHITAH.

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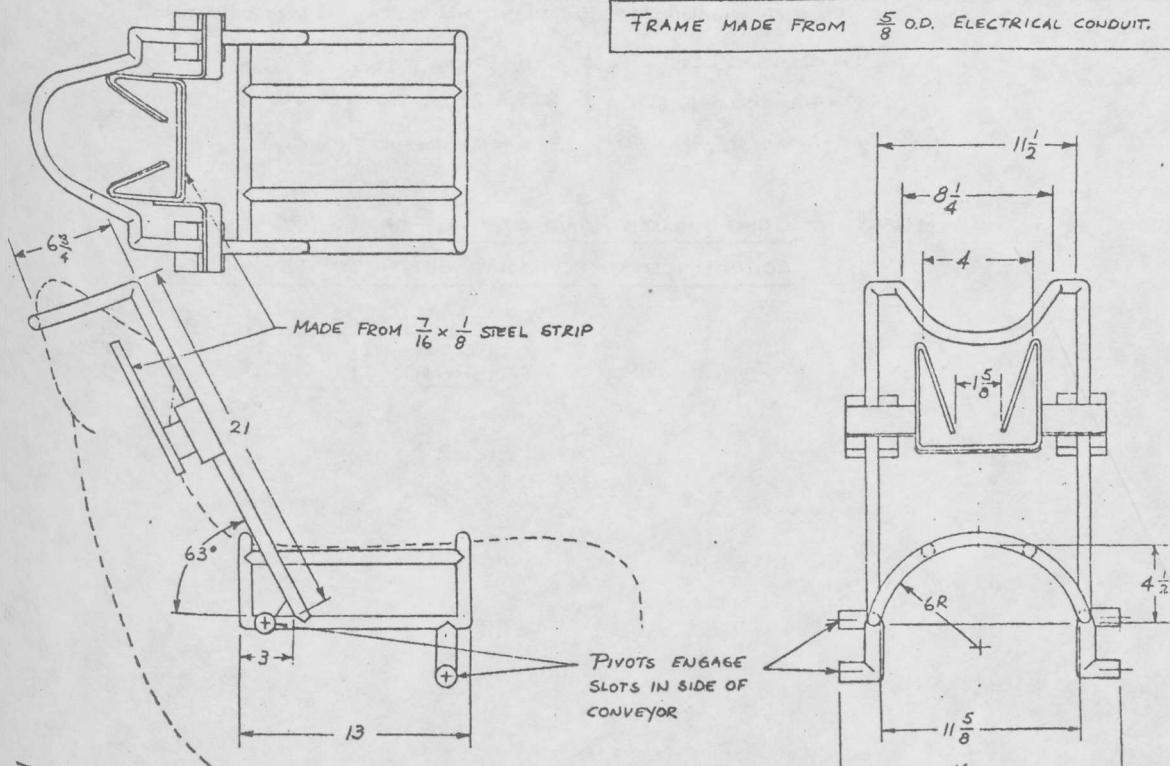
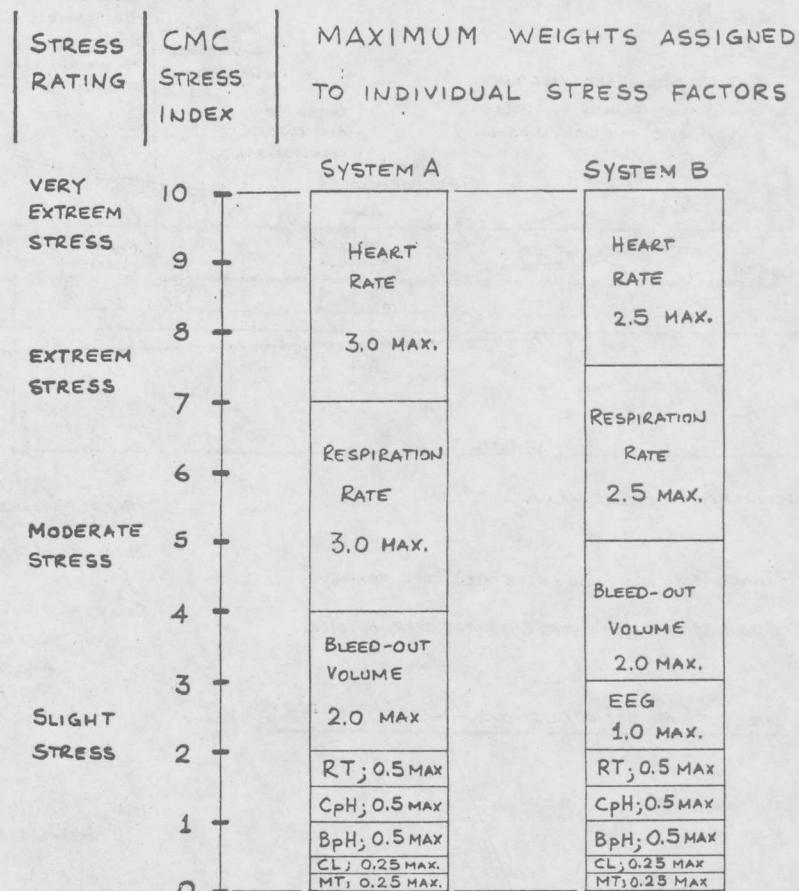


FIG. 4. HOLDDOWN-NECKSTRETCHER FRAME FOR SHEEP

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SYSTEM B INCLUDES ELECTRENCEPHALOGRAH AS STRESS FACTOR

CL = COOKING LOSS

MT = MEAT TENDERNESS

CpH = CARCASS pH

BpH = BLOOD pH

RT = RECTAL TEMPERATURE

EEG = ELECTROENCEPHALOGRAH

**FIG. 5. COMPONENTS AND RATING OF CONNECTICUT MULTICOMPONENT STRESS INDEX**

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