

A guide for Umpires

Thesis for 4th Dan
Darren Ward
NZ-3-54

Contents

| | |
|---|----|
| Forward..... | 3 |
| Entering and Leaving the Ring..... | 4 |
| Entering the ring..... | 4 |
| Leaving the Ring..... | 4 |
| Jury Members..... | 5 |
| Individual Patterns..... | 5 |
| Team Patterns..... | 5 |
| Individual Sparring..... | 6 |
| Team Sparring..... | 6 |
| Jury hand signals..... | 8 |
| Centre Referees..... | 9 |
| Individual Sparring..... | 9 |
| Team Sparring..... | 11 |
| Commands used by the referee..... | 12 |
| Warnings..... | 13 |
| How to give a warning..... | 13 |
| Fouls..... | 16 |
| How to give a Foul..... | 16 |
| Patterns Judge..... | 18 |
| Corner Referee..... | 19 |
| Special Technique..... | 20 |
| Power..... | 20 |
| Appendix 1 - Ring Set up..... | 21 |
| Appendix 2 - Sparring Jury Master Sheet..... | 23 |
| Appendix 3 – Sparring Score Sheet..... | 25 |
| Appendix 4 – Individual Patterns Score Sheet..... | 27 |
| Appendix 5 – Team Patterns Score Sheet..... | 29 |
| Presentation, Team - Work, Choreography..... | 30 |
| Acknowledgements..... | 31 |

Forward

This Guide is designed to give a helping hand to those who have attended an Umpire's course run by the International Taekwon-Do Foundation (NZ) inc. It is not designed to replace the courses run by the Tournament Sub-committee, but aid in the retention of the course material.

This guide should be used as a reference point to help you through the rules as laid down in the ITFNZ Tournament Rules (these can be downloaded from <http://www.itfnz.org.nz/ref/tournaments/index.htm>)

The guide is broken down into the individual components that make up what an Umpire may be required to carry out during the course of a Tournament.

Entering and Leaving the Ring

Entering the ring

1. All judges/referees line up outside the **left** side of the ring with the head judge / Centre referee at the front
2. March in and stop at the front of the Jury's table
3. Centre referee / Head Judge gives command "CHARYOT"
4. The Centre referee / Head Judge waits until the jury president stands and then gives command "KYONG YE"
5. As soon as the Jury President sits the judges are able to move to their respective positions.

Leaving the Ring

After all bouts are completed this is the procedure for closing a ring:

1. All judges/referees line up in front of the jury's table with the head judge / Centre referee at the front
2. Centre referee / Head Judge gives command "CHARYOT"
3. The Centre referee / Head Judge waits until the jury president stands and then gives command "KYONG YE"
4. As soon as the Jury President sits the judges are walk off to the **right** side of the ring and leave the ring
5. When outside the ring the judges stop and the head judge / Centre referee turns and faces the others.
6. The next in line gives the command "CHARYOT", then gives the command "KYONG YE"
7. The judges are free to disperse

Jury Members

General Tips

- Arrange score sheets vertically in a line rather than by who won
- Do a quick audit of the score sheet if something looks wrong or out of place
- If at any time you need clarification from a corner judge as to what they have written down, call them up
- If you see addition is wrong call up the judge and have them fix the score - do not do it yourself as this may lead to an appeal.

Individual Patterns

General Duties

- Ensure the competitors are the correct ones
- Ensure that the refereeing and corner judging is consistent and fair
- The Jury will select the designated pattern by picking it out of a hat

At the end of the bout

- 1) Jury checks scores and works out the result of the bout
- 2) The jury member stands up with arms at shoulder level with arms on top of each other
- 3) The jury member gives the result of the bout i.e.
 - a. Red wins "HONG SUNG"(left hand is raised)
 - b. Blue wins "CHONG SUNG" (right hand is raised)
 - c. Draw (both hands up in a x-knifehand checking block position)

The jury member updates any draws to reflect the result of the match (this can alternatively be done by the ring recorder)

Team Patterns

General Duties

- Ensure the competitors are the correct ones
- Ensure that the refereeing and corner judging is consistent and fair
- The Jury will select the designated pattern by picking it out of a hat

At the end of the bout

- 4) Jury checks scores and works out the result of the bout
- 5) The jury member stands up with arms at shoulder level with arms on top of each other
- 6) The jury member gives the result of the bout i.e.
 - a. Red wins "HONG SUNG"(left hand is raised)
 - b. Blue wins "CHONG SUNG" (right hand is raised)
 - c. Draw (both hands up in a x-knifehand checking block position)

The jury member updates any draws to reflect the result of the match (this can alternatively be done by the ring recorder)

Individual Sparring

General Duties

- Ensure the competitors are the correct ones
- Ensure that the refereeing and corner judging is consistent and fair
- Keep track of warning and fouls and announce them at the end of the bout (noting the warnings/fouls can be done by the ring's recorder if one is present).

At the end of the bout

- 7) The jury member stands up and gives out the number of warnings and fouls incurred by each competitor (note this may not need to be done if a large scoring system is visible to all judges)
- 8) Jury checks scores and works out the result of the bout
- 9) The jury member stands up with arms at shoulder level with arms on top of each other
- 10) The jury member gives the result of the bout i.e.
 - a. Red wins "HONG SUNG"(left hand is raised)
 - b. Blue wins "CHONG SUNG" (right hand is raised)
 - c. Draw (both hands up in a x-knifehand checking block position)
- 11) The jury member updates any draws to reflect the result of the match (this can alternatively be done by the ring recorder)

Team Sparring

General Duties

- Ensure that the refereeing and corner judging is consistent and fair
- Keep track of warning and fouls and announce them at the end of the bout (noting the warnings/fouls can be done by the ring's recorder if one is present).

At the end of each bout

- 1) The jury member stands up and gives out the number of warnings and fouls incurred by each competitor (note this may not need to be done if a large scoring system is visible to all judges)
- 2) Jury checks scores and works out the result of the bout
- 3) The jury member stands up with arms at shoulder level with arms on top of each other
- 4) The jury member gives the result of the bout i.e.
 - a. Red wins "HONG SUNG"(left hand is raised)
 - b. Blue wins "CHONG SUNG" (right hand is raised)
 - c. Draw (both hands up in a x-knifehand checking block position)

- 5) The jury notes down the number of points awarded for that bout (i.e. 2 points for a win, 1 point for a draw)

At the end of the team match

- 1) The jury member stands up with arms at shoulder level with arms on top of each other
- 2) The jury member gives the result of the bout i.e.
 - a. Red wins "HONG SUNG"(left hand is raised)
 - b. Blue wins "CHONG SUNG" (right hand is raised)
- 3) The jury member updates any draws to reflect the result of the match (this can alternatively be done by the ring recorder)

Table of Results

The following can be used as a cheat sheet to help determine the winner of a bout

Patterns

| Judge A | Judge B | Judge C | Result |
|---------|---------|---------|--------|
| Red | Red | Blue | Red |
| Red | Draw | Draw | Red |
| Red | Draw | Blue | Draw |
| Draw | Draw | Draw | Draw |

Sparring

| Judge 1 | Judge 2 | Judge 3 | Judge 4 | Individual result | Team result |
|---------|---------|---------|---------|-------------------|---------------------|
| RED | RED | RED | BLUE | <i>RED</i> | <i>RED+2</i> |
| RED | RED | BLUE | DRAW | <i>RED</i> | <i>RED+2</i> |
| RED | RED | DRAW | DRAW | <i>RED</i> | <i>RED+2</i> |
| RED | DRAW | DRAW | DRAW | <i>DRAW</i> | <i>RED+1,BLUE+1</i> |
| RED | RED | BLUE | BLUE | <i>DRAW</i> | <i>RED+1,BLUE+1</i> |

Jury hand signals

Note these are usually done from behind the jury's desk



Intermediate position before giving result



Draw



Blue wins



Red Wins



Call one Corner Judge up to the front desk



Call all Corner Judges up to the front desk

Centre Referees

Duties:

- Check to see if the competitors are the correct ones for the bout
- Record the score as they see it
- Record total warnings and fouls (This will be announced by the Jury President) and then make the correct number of deductions
- Tally up the scores
- Hand the form over to the center Referee in the correct manner

General Tips:

- Use the referee's triangle (i.e. Try and use the three sides of the ring not occupied by the jury table).
- Make sure hand signals are crisp and clear so that everyone can see them.
- For hand signals, think of the thought process of
 - 1) You did it,
 - 2) This is what you did, and
 - 3) This is what you get for it.
- Look at infringements, not at points.
- Stay 2m away from competitors.
- Call everything, but get the match started again as quickly as possible. (This is partly experience and partly technique.)

Individual Sparring

Start of Bout

- 1) Referee calls competitors into ring "HONG, CHONG"
- 2) Competitors face the jury. Referee gives command "CHARYOT"
- 3) Then referee gives command "KYONG YE"
- 4) Competitors face each other, then Referee gives command to bow -"KYONG YE"
- 5) Referee checks safety equipment - hands outer and inner, forearm guards, head gear, mouth guard
- 6) Referee checks safety equipment - groin guard, shins, feet protectors
- 7) Referee checks safety equipment - turns competitors around to check for tags on back and to check heel of the feet protectors
- 8) Referee gives command "JUNBI" and competitors step back into a guarding stance, while the referee keeps their hand outstretched between the competitors.
- 9) Referee raises one finger in the air to signal the first round ("IL HUE JON"), and completes a quick visual check of all the corner judges and jury to see if they are paying attention.
- 10) Referee drops their arm and gives command to begin "SHI JAK"

After of the first round

- 1) Referee gives command "HAECHO"
- 2) Competitors go back to centre of the ring and face each other.
- 3) Competitors face each other, then Referee gives command to bow -"KYONG YE"
- 4) Competitors go to their respective coaches/seconds.

Start of Round Two

- 1) Competitors face each other, then Referee gives command to bow -"KYONG YE"
- 2) Referee gives command "JUNBI" and competitors step back into a guarding stance, while the referee keeps their hand outstretched between the competitors.
- 3) Referee raises two fingers in the air to signal the second round ("I HUE JON"), and completes a quick visual check of all the corner judges and jury to see if they are paying attention.
- 4) Referee drops their arm and gives command to begin "SHI JAK"

After the Second Round

- 1) Referee gives command "GOMAN"
- 2) Competitors go back to centre of the ring and face each other.
- 3) Competitors face each other, then Referee gives command to bow -"KYONG YE"
- 4) Competitors face the front and are commanded to sit "ANJO"

At the end of the Match

- 1) Competitors are asked to stand up by the referee "EROSO"
- 2) Competitors face the jury. Referee gives command "CHARYOT"
- 3) Then referee gives command "KYONG YE"
- 4) Competitors face the jury president and wait for the Jury President to announce the result.
- 5) At the same time the result is given by the jury president, the referee raises the winner's arm.
- 6) (if a draw is the result, both arms are raised)

In the case of a draw after the second round

- 1) Competitors face each other, then Referee gives command to bow -"KYONG YE"
- 2) Referee gives command "JUNBI" and competitors step back into a guarding stance, while the referee keeps their hand outstretched between the competitors.
- 3) Referee raises three fingers in the air to signal the third round ("SAM HUE JON"), and completes a quick visual check of all the corner judges and jury to see if they are paying attention.

- 4) Referee drops their arm and gives command to begin "SHI JAK"
- 5) After round 3 get competitors to sit down again

In the case of a draw after the Third round

- 6) Competitors face each other, then Referee gives command to bow -"KYONG YE"
- 7) Referee gives command "JUNBI" and competitors step back into a guarding stance, while the referee keeps their hand outstretched between the competitors.
- 8) Referee raises four fingers in the air to signal the fourth round, and completes a quick visual check of all the corner judges and jury to see if they are still paying attention.
- 9) Referee drops their arm and gives command to begin "SHI JAK"
- 10) During this round the referee will stop the bout if either a foul is committed, or if 2 judges stand up and yell "POINT"
- 11) When this happens, the referee will bring the competitors back into the center of the ring.
- 12) If at the end of the 1 minute round no points were scored, then the referee will take the competitors to a set of scales to verify the lightest competitor.
- 13) Competitors face the jury. Referee gives command "CHARYOT"
- 14) Then referee gives command "KYONG YE"
- 15) Competitors face the jury president and wait for the Jury President to announce the result.
- 16) At the same time the result is given by the jury president, the referee raises the winner's arm.

Team Sparring

Start of Team Match

- 1) Referee calls teams into ring "HONG, CHONG"
- 2) Teams face the jury. Referee gives command "CHARYOT"
- 3) Then referee gives command "KYONG YE"
- 4) Teams face each other, then Referee gives command to bow -"KYONG YE"
- 5) Referee tosses a coin up and the team that wins the toss is given the choice of putting up a competitor first or leaving that decision to the other team.
- 6) Teams bow and return to their respective sides of the ring

At the end of the Bout

- 1) Competitors are asked to stand up by the referee "EROSO"
- 2) Competitors face the jury. Referee gives command "CHARYOT"
- 3) Then referee gives command "KYONG YE"
- 4) Competitors face the jury president and wait for the Jury President to announce the result.

- 5) At the same time the result is given by the jury president, the referee raises the winner's arm. (if a draw is the result, both arms are raised)

End of a Team Match

- 1) Referee calls teams into ring "HONG, CHONG"
- 2) Teams face the jury. Referee gives command "CHARYOT"
- 3) Then referee gives command "KYONG YE"
- 4) Competitors face the jury president and wait for the Jury President to announce the result.
- 5) At the same time the result is given by the jury president, the referee raises the arm of the team captain.

Commands used by the referee

- | | |
|----------------|--------------------|
| (a) Cha Ryot | Attention |
| (b) Kyong Ye | Bow |
| (c) Jun Bi | Ready |
| (d) Shijak | Begin |
| (e) Haechyo | Separate |
| (f) Gaesok | Continue |
| (g) Goman | End |
| (h) Ju Ui | Warning |
| (i) Gam Jum | Foul |
| (j) Sil Kyuk | Disqualification |
| (k) Hong Sung | Win by red corner |
| (l) Chong Sung | Win by blue corner |
| (m) Jung ji | Time Out |
| (n) Hong | Red |
| (o) Chong | Blue |
| (p) Anjo | Sit down |
| (q) Eroso | Stand Up |

Warnings

How to give a warning

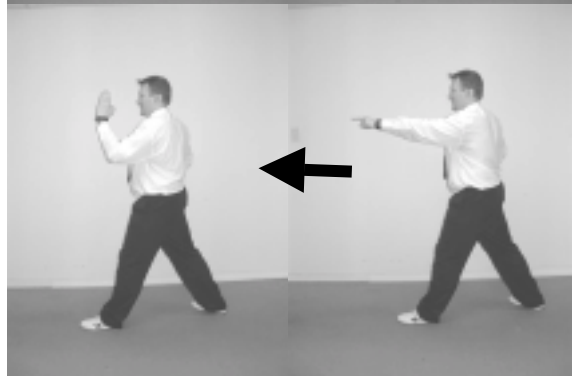
- 1) The Centre Referee stops the bout temporarily by calling separate - "HAECHO"
- 2) The referee points at the competitor who committed the warning



- 3) Raise the hand straight in the air and hold the other hand out still pointing at the competitor who committed the offense



- 4) After the signal has been made the referee gives the command to continue "GAESOK"



Warnings may be issued for the following offences:

- 1) Attack to an illegal target



2) Stepping completely out of the ring



3) Falling down, whether intentional or not



4) Not using enough correct technique. (previously light contact)

5) Holding, grabbing or pushing



Holding



Pushing

6) Sweeping



7) Intentionally avoiding sparring

8) Pretending Pain

9) Turning the back, except while executing a legitimate technique e.g. back kick.



10) Performing uncontrolled techniques



11) Talking during the bout

Fouls

How to give a Foul

- 1) The Centre Referee stops the bout temporarily by calling separate - "HAECHO"
- 2) The referee points at the competitor who committed the foul



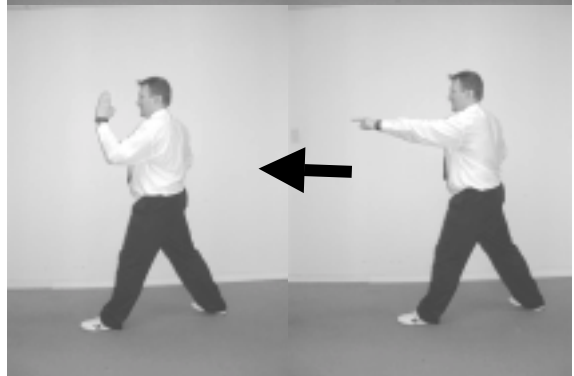
- 3) The referee pulls a yellow card from their pocket and raises it in the air while keeping the hand pointing at the competitor who has committed the offense



- 4) If no card is available you can use a hand signal instead – this is done by raising the hand in the air and rotating it around in a circular motion



- 5) After the signal has been made the referee gives the command to continue "GAESOK"



1) Attacking a competitor who has fallen.



2) Butting, biting, scratching or clawing.

3) Intentionally attacking after the declaration of “BREAK”, “GOMAN” or “HAECHYO”

4) Making insulting remarks or abusive gestures during the progress of the bout.



5) Using the knee, elbow or forearm as an attacking tool.

6) Deliberate heavy contact of attack or defense during a touch-contact contest



Patterns Judge

Duties

- The referee must observe with attention the competitors' actions and take into consideration and judge according the following criteria:

| | Individual | Team |
|---------------------------------------|------------|----------|
| Technical Content | 5 points | 5 points |
| Power | 3 points | 3 points |
| Balance | 3 points | 3 points |
| Breath Control | 3 points | 3 points |
| Rhythm | 3 points | 3 points |
| Presentation, teamwork & choreography | | 5 points |

- After each bout the referee must add up all the points on his/her Pattern scoring form, which will be collected by a Jury member and handed over to the Jury President
- In the event of a tie the Jury President will select by drawing one (1) designated Pattern to be the Tie-breaker. The competitors/teams will then carry on until the winner(s) are decided.

General Notes

- The referee is not allowed to talk during the competition (with the exception of consultation with the Jury President)
- The referee should sit correctly (upright, with the back straight and with the soles of the feet on the floor) with a space of 150cm either side of his colleagues

Corner Referee

Duties:

- Check to see if the competitors are the correct ones for the bout
- Record the score as they see it
- Record total warnings and fouls (This will be announced by the Jury President) and then make the correct number of deductions
- Tally up the scores
- The Corner Referee must sit properly and must observe with attention the competitors' actions;
- Hand the score sheet over to the center Referee in the correct manner
 - *Case 1 – Ring has no runners to get the score sheets:* Stand up and walk over to the Centre Referee and bow when giving the form
 - *Case 2 – ring has a runner to collect the score sheets:* Stand up and bow to the runner as they come to get the score sheet

General Notes

- The Corner Referee is allowed to take part in the consultations between the Jury Presidents and the Centre Referee if required

Methods for writing and watching at the same time:

- 1) Watch a flurry, then write in the pause
- 2) Hold the clipboard at eye level and do both at the same time. Position the pen at a pivot point between red and blue - left or right of the pivot point for red and blue

Dealing with a "first point" round

This requires all corner judges to have both a red and blue flag to signal the winner. The corner referee will sit down and watch the bout until they see a valid point scored on one of the competitors. When this happened the Corner judge will stand up with the appropriate flag and shout "Sung" (Winner).

If there are 2 flags of the same colour up at the time the referee calls "BREAK" then the winner is decided.



Good posture for sitting



Bad postures for sitting



Special Technique

Duties

- Ensure that the height/distances are the same for each competitor
- Ensure that the correct attacking tool is used when the competitor is executing the required technique(s) – failure to do this by the competitor will see them given no points for the technique.
- Ensure that the competitor starts and ends in a L-Stance forearm guarding block.
- Ensure that balance is maintained by the competitor i.e. if they touch the ground with anything else except their feet no points shall be awarded
- Choosing a technique for a "tie breaker"
- If boards are used instead of an approved device for holding special techniques, then all boards should be checked for a crack/break in them after the technique is executed.
- Ensure that if a competitor has not completed the following sequences after 30 seconds after the referee's signal after the pre-judge (ready stance → hit target → ready stance) that no points are awarded.

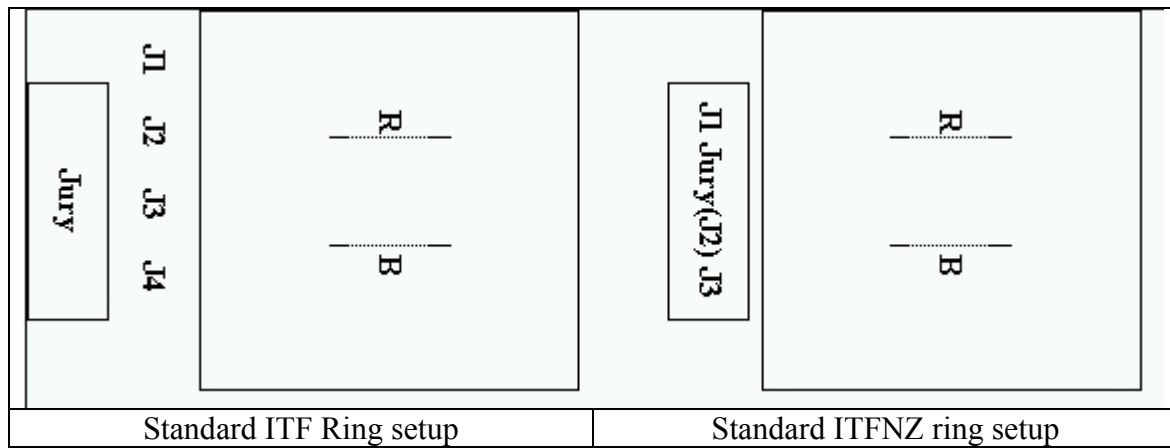
Power

Duties

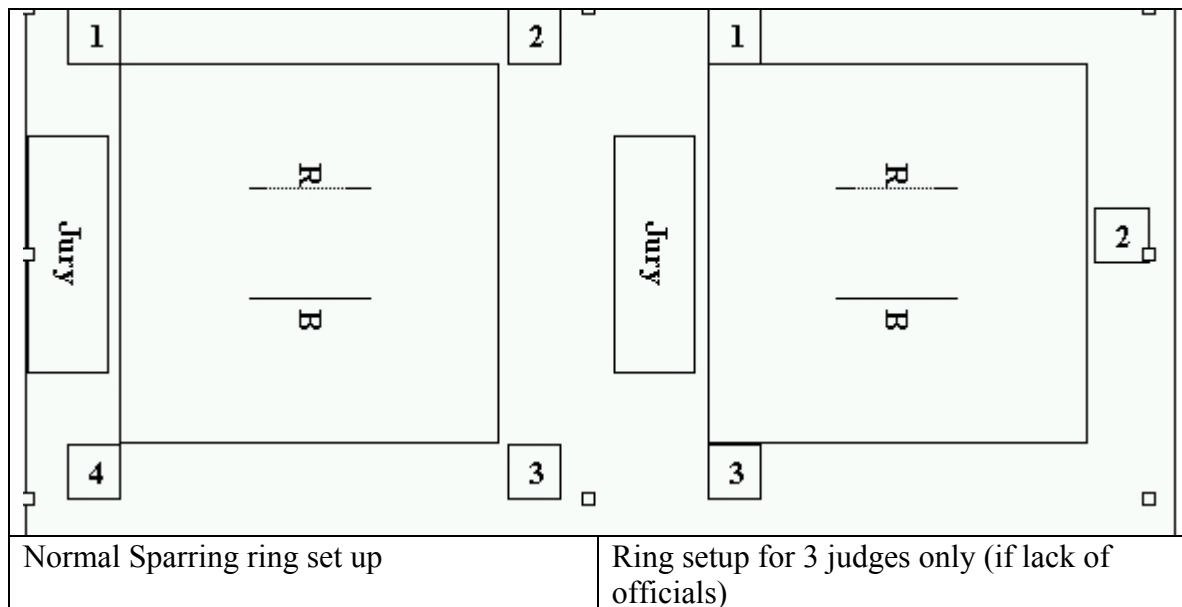
- Ensure that the correct attacking tool is used when the competitor is executing the required technique(s) – failure to do this by the competitor will see them given no points for the technique.
- Ensure that the competitor starts and ends in a L-Stance forearm guarding block.
- Ensure that balance is maintained by the competitor i.e. if they touch the ground with anything else except their feet no points shall be awarded
- Choosing a technique for a "tie breaker"
- Ensure that boards are replaced after each attempt at breaking. The boards that have been used in previous attempts should not be reused during the competition (unless re-breakable boards are being used, then there is no problem with reusing the boards)
- If boards are used instead of an approved device for holding special techniques, then all boards should be checked for a crack/break in them after the technique is executed.
- Ensure that if a competitor has not completed the following sequences after 30 seconds after the referee's signal after the pre-judge (ready stance → hit target → ready stance) that no points are awarded.

Appendix 1 - Ring Set up

Patterns



Sparring



Appendix 2 - Sparring Jury Master Sheet





Jury Master Sparring Form

Fold around Judges' scoresheets


| | | | |
|---|----------------------|-----------------------------|------------------|
| RING/BOUT NUMBER: | | TIME AT END OF BOUT: | |
| DIVISION: | | | |
| REFEREE: | | | |
| JURY PRESIDENT: | | | |
| RED | NAME: | | |
| | REGION: | | |
| BLUE | NAME: | | |
| | REGION: | | |
| RED | Warnings | BLUE | |
| Total | Fouls | Total | |
| | | Total Subtractions | |
| # of Judges' Decisions at End of 2nd Round | | | |
| WIN RED: | | DRAW: | WIN BLUE: |
| If Draw, # of Judges' Decisions at End of 3rd Round | | | |
| WIN RED: | | DRAW: | WIN BLUE: |
| RED | CIRCLE WINNER | BLUE | |
| <u>NOTES</u> | | | |


Appendix 3 – Sparring Score Sheet

|  Sparring Score Sheet | | | | |
|---|----------------------|---------------|----------------------|----------------------|
| | | | Ring N° | <input type="text"/> |
| <input type="text"/> | | 1 pt | | <input type="text"/> |
| <input type="text"/> | | 2 pt | | <input type="text"/> |
| <input type="text"/> | | 3 pt | | <input type="text"/> |
| <u>Subtotal</u> | | | | <u>Subtotal</u> |
| <u>Sub-tractions</u> | | Warnings | | <u>Sub-tractions</u> |
| | <input type="text"/> | Fouls | <input type="text"/> | |
| Total | RED | Circle Winner | BLUE | Total |
| JUDGE: | | | | |
| DIVISION: | | | | |

|  Sparring Score Sheet | | | | |
|---|----------------------|---------------|----------------------|----------------------|
| | | | Ring N° | <input type="text"/> |
| <input type="text"/> | | 1 pt | | <input type="text"/> |
| <input type="text"/> | | 2 pt | | <input type="text"/> |
| <input type="text"/> | | 3 pt | | <input type="text"/> |
| <u>Subtotal</u> | | | | <u>Subtotal</u> |
| <u>Sub-tractions</u> | | Warnings | | <u>Sub-tractions</u> |
| | <input type="text"/> | Fouls | <input type="text"/> | |
| Total | RED | Circle Winner | BLUE | Total |
| JUDGE: | | | | |
| DIVISION: | | | | |

Appendix 4 – Individual Patterns Score Sheet

|  ITF NZ Taekwon-Do | | | | | | <i>Individual Patterns Score Sheet</i> | | | |
|---|-----------------|------------|---|--------------|----------|--|--|--|--|
| Ring N° | | RED (HONG) | | BLUE (CHONG) | | | | | |
| | | O | D | <u>O</u> | <u>D</u> | | | | |
| Technical Content | Max 5 | | | | | | | | |
| Power | 3 | | | | | | | | |
| Balance | 3 | | | | | | | | |
| Breath Control | 3 | | | | | | | | |
| Rhythm | 3 | | | | | | | | |
| Sub Total | | | | | | | | | |
| TOTAL (O+D) | | | | | | | | | |
| JUDGE: | | | | | | | | | |
| DIVISION: | | | | | | | | | |

|  ITF NZ Taekwon-Do | | | | | | <i>Individual Patterns Score Sheet</i> | | | |
|---|-----------------|------------|---|--------------|----------|--|--|--|--|
| Ring N° | | RED (HONG) | | BLUE (CHONG) | | | | | |
| | | O | D | <u>O</u> | <u>D</u> | | | | |
| Technical Content | Max 5 | | | | | | | | |
| Power | 3 | | | | | | | | |
| Balance | 3 | | | | | | | | |
| Breath Control | 3 | | | | | | | | |
| Rhythm | 3 | | | | | | | | |
| Sub Total | | | | | | | | | |
| TOTAL (O+D) | | | | | | | | | |
| JUDGE: | | | | | | | | | |
| DIVISION: | | | | | | | | | |

Appendix 5 – Team Patterns Score Sheet

| Ring N° | | RED (HONG) | | BLUE (CHONG) | |
|---|------------------------|-------------------|----------|---------------------|-----------------|
| | | O | D | <u>O</u> | <u>D</u> |
| Presentation, Team - Work, Choreography | Max 5 | | | | |
| Technical Content | 5 | | | | |
| Power | 3 | | | | |
| Balance | 3 | | | | |
| Breath Control | 3 | | | | |
| Rhythm | 3 | | | | |
| Sub Total | | | | | |
| TOTAL (O+D) | | | | | |
| JUDGE: | | | | | |
| DIVISION: | | | | | |

| Ring N° | | RED (HONG) | | BLUE (CHONG) | |
|---|------------------------|-------------------|----------|---------------------|-----------------|
| | | O | D | <u>O</u> | <u>D</u> |
| Presentation, Team - Work, Choreography | Max 5 | | | | |
| Technical Content | 5 | | | | |
| Power | 3 | | | | |
| Balance | 3 | | | | |
| Breath Control | 3 | | | | |
| Rhythm | 3 | | | | |
| Sub Total | | | | | |
| TOTAL (O+D) | | | | | |
| JUDGE: | | | | | |
| DIVISION: | | | | | |

Acknowledgements

I would like to give thanks to the following people, without whom I could not have completed this thesis

Mark Banicevich for his initial input into helping me get started in writing this document

Dave Oliver for his help with the use of the digital camera, and converting the files into a manageable format.