TECHNICAL CONTROLLERS' HANDBOOK

prepared by:
WSWC Officials' Committee

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TABLE OF CONTENTS

APPENDICES

Official's Code of Conduct
Resolving / Reporting Problems
Jump Measurement Benchmark
Slalom Course Diagram
Jump Course Diagram
Trick Course Diagram
Sample Survey Data & Results
TC Dossier
Course Survey Dossier

INTRODUCTION

In preparing for a tournament, the importance of selecting a proper site and assuring proper facilities for the Slalom, Jump and Trick events cannot be overstated. Many things can go wrong during a tournament and the skiers and spectators will forgive and forget, but a poor tournament site, an improperly laid slalom course, a poorly constructed jump ramp or a faulty trick course will still spell disaster for any tournament.

In this manual we will discuss the technical aspects of laying out and measuring a tournament site to meet the requirements of a sanctioned, record capability event. This manual will describe what must be done before, during and after a tournament.

Your responsibility as Technical Controller or Homologator is to ensure that everyone has a fair opportunity to compete, and particularly also to ensure that all the standards at your event are *EQUAL* to any other Record Capable event.

The Technical Controller must be aware of the specific record capability standards to be maintained. Make sure you know which standards apply, whether they are Canadian Record Capability or World Record Capability standards. Both Water Ski & Wakeboard Canada and the International Water Ski Federation (IWSF) have specific standards which must be met. Similarly, events sanctioned for World Ranking List standards may also have specific requirements.

You must also be very familiar with the rules and their application, similar to the Judges. Your relationship to the Chief of Competition is also important. Be sure to work with the Chief of Competition at all times. The Chief of Competition is responsible for over-seeing the entire event.

There are many basic items that must be considered to hold a successful and properly homologated tournament. Each will be addressed in further detail later in this manual.

SAFETY

Safety is easily overlooked in our efforts to get the job done. We must however, constantly consider the safety of everything we do as it may affect anyone, including competitors, officials, and spectators. Do your best to ensure your safety as you work the event, and to ensure the safety of others throughout the event.

Report any safety concerns to the Chief of Competition and/or the event Safety Director.

GENERAL PHILOSOPHY OF MEASUREMENTS & TOLERANCES

Where you have the ability to set or select any measurement such as the jump ramp slope or the distances and lengths in the courses, you should strive to set these to the actual specification as defined in the official rule.

In other words, all variation tolerances are only to allow for human error, not to provide any advantage to the competitor. Tolerances are not to be used to help a skier get his best score! If you do this, you are disadvantaging all the skiers who did not compete in this event. You will often encounter comments where skiers like something set a certain way, usually some way that makes the event easier or the results higher. The best competitors however know what's right!

Remember, more than anything, your job is to make this event equal to all other events.

As an example, the jump ramp slope ratio should be one of 0.235, 0.255, or 0.271, depending on the division. It *should not* be set to the maximum that the tolerance allows (i.e. 0.238, 0.258, or 0.274, respectively).

Your rule book is very clear on this! Do your best to ensure that everything is as close to perfect as possible.

SITE AND FACILITIES

Jumping:

Historically used, the Johnson Metering system for measuring distance in water ski jumping is based on principles of geometry and trigonometry applied in the use of three sighting stations located on or near the shoreline. This system has been in use for some time but more recently, new and innovative video/computer measurement systems have been in use, requiring different setup and verification techniques. These video methods are now required to achieve World level standards.

The course, jump ramp and measurement system must be laid out carefully and accurately to ensure consistent boat speeds, boat paths and jump distance measurement.

In addition, the jump ramp slope must be carefully set, the towropes properly prepared and the masterboard or measurement system correctly set up.

Slalom:

The slalom course is of principle concern here. Like the jump event, it must be laid out accurately to ensure all measurements are within the appropriate tolerances for the level of sanction applied.

The towropes must measure to the prescribed standards and the timing systems must be checked also. The use of speed control is now common and generally required, so ensure they are of an appropriate configuration.

Tricks:

The trick course is comparatively easily prepared, but the timing system will receive the same attention as for the other two events.

Judging Facilities:

All the judges' facilities should be inspected to ensure they are adequate. Check that any towers are high enough, that all locations provide clear views, and that adequate communications are provided.

Electronic Systems:

These days, electronic devices and systems are becoming more and more common. While these help to make the judging more accurate and fair, they do require that we have an understanding of them. Timing equipment, whether manual, semi-automatic, or automatic must be verified to ensure correct and accurate operation as they apply to each of the events. Video and computer are now also virtually standard equipment for tournaments. You should become familiar with their operation and it is useful to develop some trouble shooting skills for those times something goes wrong.

BEFORE THE TOURNAMENT

SITE PREPARATION

Course Surveys

In order to ensure that the courses or buoy positions conform to Canadian or World Record Capable standards a survey of the courses must be completed. This will provide a check of all relative dimensions on the water.

This survey must be normally completed between 30 and 10 days prior to the start of the tournament. This survey must be conducted by a qualified, licensed surveyor or other person approved by Water Ski & Wakeboard Canada.

Generally the survey will have been completed by the organizer, however you should have an understanding of this process. You may also do a survey yourself, or have to verify that a particular site does in fact measure up to standards by doing a follow-up survey.

Two methods are commonly used to do a survey of the courses. The first and the preferred method is the three station baseline method which sights all buoys from three stations and triangulates their positions (very similar to the former manual jump distance measurement). This method provides the best accuracy and is most verifiable.

Newer technologies make available equipment which automate some measurements allowing, for example, measurement from a single station based on a Polar Coordinate system. This is commonly called EDM or Electronic Distance Measurement. The instrument is often known as a “Total Station” This system generally sights on a reflector prism which must be placed at each target position (buoy). From this sighting, the instrument very accurately determines not only the horizontal and vertical angle, but also actual distance from the instrument to the prism or buoy.

One final point, the survey should be done in conditions that will be the same as for the event. If glass calm is typical, then the survey should be done under those conditions. In fact, even a light wind can alter the position of the buoys significantly and make surveying a frustrating experience!

Tips:

One suggestion to try is to survey the course with the buoys at least one half submerged. This will help to ensure the buoys are directly over their anchors. If the anchor lines are at all slack and there is any wind, you will have trouble getting acceptable results. It may also help to place a wad of gum or other marker on the top of the buoy to help sight its centre (remember to remove if it is in the sun too long!).

Three Station Baseline Survey

The approved/recommended survey method is a three station baseline survey using a theodolite or transit. A theodolite is essentially a telescope which has been calibrated to measure angles very accurately across the horizontal plane. In general, these instruments measures angles in degrees, minutes, and seconds of arc. (One degree equals sixty minutes, and one minute equals sixty seconds of arc.)

In practice, you measure the distance between the station positions and the angles to each buoy. From this data you can calculate any relative distance very accurately using trigonometric and linear algebra principles. This method is not unlike the traditional jump measurement technique, just more detailed and more accurate. This method applies equally to both the slalom and jump courses.

In addition, this survey method's special bonus is that you get to keep your feet dry!

A table is provided on the next page to record your sighting data.

Equipment:

You will require a theodolite or transit which can be read to at least twenty seconds or less of arc. Most current instruments will meet or exceed this criteria. You also need a "chain" or tape to measure the baseline of the survey. Using a steel tape is preferred, rather than a nylon tape measure which may have a tendency to stretch under excessive tension.

Setup and Data Collection:

You will be sighting all the buoys and the jump from three positions on shore which must lie in a straight line, somewhat parallel to the course. Before you begin it is worth a few minutes to roughly select these positions so that they will be in a line and will all have a clear view of the buoys and the other stations. The baseline should be fairly long, about 75 to 125 meters between station positions if possible. This baseline is critical. If it is not done carefully *ALL* your readings will be incorrect.

Sightings should be on the midpoint of the spherical buoy at rest. If there is a current or prevailing wind, the survey should be conducted in conditions which will most approximate the tournament conditions.

Your first station (A) should be towards the end of the Slalom Course which will have Buoys G1/G2 (your left, facing the course), or for the Jump Course nearest Buoy 15EC (I). Carefully mark this spot with a stake, using the instrument's plumb sight. Select and also mark the second station (B) with a stake. Measure and record the distance between stations A and B to at least +/-0.01m. You may measure even more accurately if you compensate for temperature and tape sag, although this is beyond the scope of this instruction.

Place the instrument over point A, taking care to level and centre the instrument over the stake or marker. Sight station B and lock the angular scale so that it reads 0 or 180 degrees on B. From here on, do not reposition the base horizontal angle scale. At each station, zero degrees should be in the same direction (along baseline towards "A"). The horizontal angle scale should increase clockwise, to your right as you face the course.

Take a sighting on each buoy being careful to sight their centres. Record the angle of each sighting as you make it. Use a table such as from your Survey Dossier or a copy of the sample Data Table in this manual to record your data. When all sightings are completed, once more sight station B to ensure the instrument was not disturbed. If you are satisfied that everything is correct at A, move the instrument to station B.

Note: If you are surveying the Jump Course, you must also sight the top corners of the jump and its top centre. Some data reduction software will also let you sight the judge tower positions. If so take a reading on the approximate centre of each judging tower (slalom).

At station B, once again level and centre the instrument over the stake. Begin by sighting back to station A and lock the scale to 180 degrees opposite the sighting from A. In other words if the angle from A to B was 180 degrees then the sight from B to A will be 0 or 360 degrees. The direction of the baseline angles must be consistent from each station.

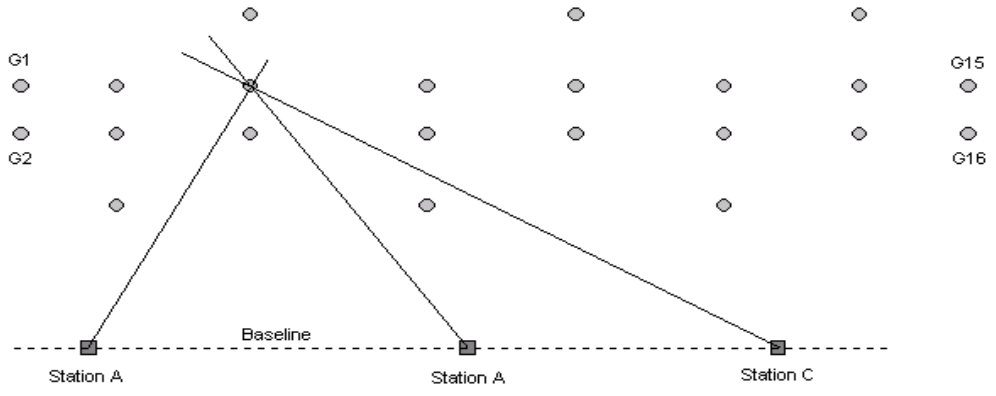
Sight each buoy as you did for station A and record all your data. When done, take another sighting to the stake at A to confirm that everything is in order. If not, back up now and check your measurements and readings.

Now, before you move the instrument, take a sighting toward station C, being careful to position the instrument 180 degrees off of station A (from B). Have a helper place a stake on that line at a suitable distance. Check to make sure that the three stakes which mark the stations are *EXACTLY* in a straight line. Even small deviations will result in large error triangles. Measure and record the distance from station B to station C.

Reposition the instrument over station C. Again take care to level and centre it over the stake. Sight back to B and lock the scale so that it is 180 degrees opposite the sighting from B to C. Sight all buoys and record your data in the same manner as for the first two stations. Make a final check on the baseline angle, sighting back to station B.

Finally, you may also need to record angles for other buoys that are part of a jump measurement system (such as for video measurement systems). Now is a good time to collect this data.

TYPICAL THREE STATION SURVEY



SLALOM SURVEY DATA TABLE

(Three Station Survey)

BUOY	AngA DEG	AngA MIN	AngA SEC	AngB DEG	AngB MIN	AngB SEC	AngC DEG	AngC MIN	AngC SEC
S1									
S2									
S3									
S4									
S5									
S6									
G1									
G2									
G3									
G4									
G5									
G6									
G7									
G8									
G9									
G10									
G11									
G12									
G13									
G14									
G15									
G16									
P1									
P2									
P15									
P16									
Tower 1									
Tower 2									
Stn A									
Stn B									
Stn C									

JUMP SURVEY DATA TABLE

(Three Station Survey)

BUOY	AngA			AngB			AngC		
	DEG	MIN	SEC	DEG	MIN	SEC	DEG	MIN	SEC
210M									
180M									
150M									
15ST									
19ST									
15MT									
19MT									
15ET									
19ET									
15EC									
19EC									
R1									
R2									
Ramp									
Test									
Mtr A									
Mtr B									
Mtr C									
A-C									

GENERAL FORMULAE FOR CALCULATING BUOY POSITIONS (THREE STATION)
(Inscribed Circle Method)

Triangle vertices coordinates:
angP1 = angA - angB
angP2 = angA - angC
angP3 = angB - angC
AP1 = (AB)(sinB) / (sin(angP1))
AYP1 = (sinA) (AP1)
AXP1 = -(cosA)(AP1)
AP2 = (AB + BC)(sinC) / (sin(angP2))
AYP2 = (sinA)(AP2)
AXP2 = -(cosA)(AP2)
BP3 = (BC)(sinC) / (sin(angP3))
AXP3 = AB - (BP3)(cosB)
AYP3 = (BP3)(sinB)

Slope of vertex bisector lines:
Mab = tan((angA+angB)/2)
Mbc = tan((angB+angC)/2)

Triangle (inscribed circle) centre location:
Xposition = (MabXab-MbcXbc-Yab+Ybc) / (Mab-Mbc)
Yposition = ((Yab/Mab)-(Ybc/Mbc)-Xab+Xbc) / ((1/Mab)-(1/Mbc))

Triangle Sides:
S1 = ((AXP1 -AXP2)**2 + (AYP1 - AYP2)**2)**1/2
S2 = ((AXP1 -AXP3)**2 + (AYP1 - AYP3)**2)**1/2
S3 = ((AXP2 -AXP3)**2 + (AYP2 - AYP3)**2)**1/2

Triangle size calculation:
One half triangle perimeter = S = (S1 + S2 + S3) / 2
Radius of Inscribed Circle = sqrt((S-S1)(S-S2)(S-S3)/S)

Error analysis:
Largest Interior Angle = L = largest of (A-B), (180-A+C), (B-C)
Sighting error = E = 2R/sin(L).

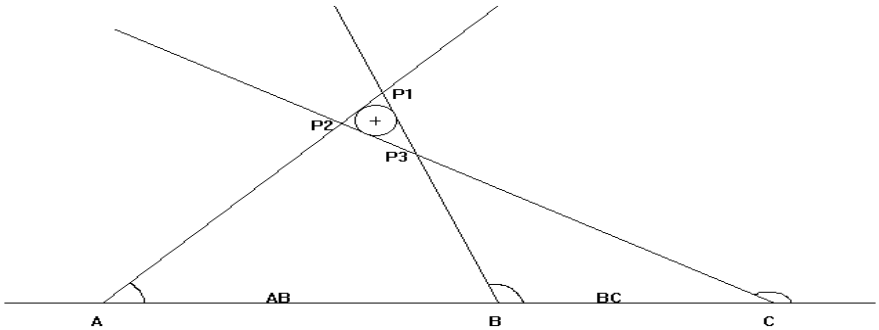


Diagram 1
Typical Sighting Lines

The EDM Survey Method

This method uses sightings from one location which provide both a distance and an angle to the target buoy. No other measurement is required. Both courses can be surveyed from one setup location, if it is carefully chosen to provide a clear view them.

Equipment:

You will require an instrument equipped with EDM (Electronic Distance Measurement) and a reflector prism. These instruments can be very accurate, but you must still be careful to set them up correctly. Also you must be aware of whether you will be reading true horizontal distance or slope distance. Some instruments will allow the user to select the displayed value.

The reflector prism must be moved from buoy to buoy as each sighting is made. Some technical controllers like to have this prism mounted on a weighted buoy which will replace the actual buoy as each sighting is made. This is the most reliable method of ensuring the reflector is correctly positioned over each buoy anchor.

Setup and Data Collection:

This technique requires you to place the instrument in one location from which you can see every target location (buoy). Take some time to find a suitable location with a clear view. With a well selected spot you could survey both courses from it. Place the instrument at this spot and carefully level and prepare it. It is good practice to stake or mark the location so you can reuse it if necessary.

A reflective prism must be placed on each buoy for it to be sighted. The instrument is then aimed at the prism, and the sighting is taken. The data will consist of a horizontal angle to the buoy and a distance from the instrument to the buoy. Make sure you know whether your instrument is giving you true horizontal distance, or slope distance, and record as appropriate. If you record the slope distance (the actual distance from the instrument to the reflector) then you must also record the vertical angle of that measurement. Horizontal distance is simple the true distance across a level, horizontal plane.

Begin by sighting on a reference object and setting a base horizontal angle on it (i.e. 0 deg). Select a reference point to the left of your survey station that will be permanent. All other sightings will be based on this reference. This reference will also serve as a setup point should you require to re-survey the site from the same station. Obtain and record the vertical height of the instrument above water level, if the instrument will be providing the slope distance for the sightings.

Work through all the buoys, collecting the angles and distances for each. Care must be taken to ensure the prism is positioned over the buoy centre or anchor line axis. Collect all the sighting data on a form such as the next page. Angles should recorded in degrees, minutes, seconds and distances in meters, to three decimal places.

SLALOM SURVEY DATA TABLE

(EDM Method)

BOUY	Horiz DEG	angle MIN	SEC	EDM Dist	Height Adjust	Vert DEG	Angle MIN	SEC
S1								
S2								
S3								
S4								
S5								
S6								
G1								
G2								
G3								
G4								
G5								
G6								
G7								
G8								
G9								
G10								
G11								
G12								
G13								
G14								
G15								
G16								
P1								
P2								
P15								
P16								
Tower 1								
Tower 2								

JUMP SURVEY DATA TABLE

(EDM Method)

BOUY	Horiz angle DEG	MIN	SEC	EDM Dist	Height Adjust	Vert Angle DEG	MIN	SEC
210M								
180M								
150M								
15ST								
19ST								
15MT								
19MT								
15ET								
19ET								
15EC								
19EC								
R1								
R2								
Ramp								
HEXM								
Test								
Mtr A								
Mtr B								
Mtr C								
A-C								

Survey Data Reduction:

With the information you now have, you can determine all relative distances between buoys. If you are ambitious, it can be done manually. But if you are like us, you will want to use a computer program or spreadsheet of which several are available. You could use the *SLALCORS* or *JUMPCORS* programs or a computer spreadsheet which is also commonly used. Internet sites from Water Ski & Wakeboard Canada or USA Waterski will lead you to these. They are based on the formulas on the previous pages for each type of survey, whether three station or EDM. If you use any of these programs, take care to follow the instructions that apply to their specific use.

The complete raw survey data and the calculated results must be forwarded to the Technical Director of Water Ski & Wakeboard Canada for verification and approval.

Record the calculated results on the course diagrams that are provided in your Survey Dossier, or on a copy from this manual.

Site Survey Results Analysis:

All calculated dimensions must be within rule tolerances. Deviations exceeding rule tolerances must be resolved and the course re-surveyed to check any adjustments. In the case of the three station survey, resulting error triangles may not exceed 0.15m (15cm). This is based on the inscribed circle method of calculating the centre position.

The jump ramp position and its angle relative to the course is also calculated. The jump position should be adjusted as necessary and re-surveyed to confirm.

The data and the results must be forwarded to Water Ski & Wakeboard Canada for final approval.

Sighting Errors:

Once you have completed surveying the course and have calculated the data, you must correct the out of tolerance results. Generally the software programs assume that the entrance and exit gate buoys are correctly placed and then calculate all other buoy positions based on a centreline that runs between the midpoint of each pair or gate.

Obviously if a gate buoy is incorrectly placed, or surveyed incorrectly, it can cause all other buoys to be incorrectly located. The first check then is to confirm that the error triangles from your survey (three station method) are small. If they are, then likely you have sighted them correctly. Again this is especially important for the gate buoys. Interpreting these results efficiently takes some experience, but can be learned.

If the gate buoys are properly spaced and have small error triangles the remainder of the calculated data might be reliable. At this point if all other measures are within tolerance, then the results are probably acceptable. If any buoys are out of tolerance, you must now consider what might be the best way to correct, remembering for example that if a particular spacing is incorrect, you might have two choices to correct it. The challenge is to bring the course into tolerance with a minimum of individual buoy moves!

Other Site Review Requirements

Additional Course Data:

The Jump and Slalom Courses must also be reviewed for the following information:

What type of course is it ?

1. cable (and configuration of cable course?)
2. individual anchors

Anchoring considerations:

1. What type of anchors are used ?
2. What do the anchors weigh ?
3. What type of bottom surface ?
4. What is the chance of anchor movement between time of survey and tournament ?
5. How are the buoys and sub-buoys attached ?

Water conditions:

1. Is there a current ? How much ? This current must be measured and may not exceed 1.5 kpH along the course axis. You can measure this by floating an object in the current and then timing its drift between two reference lines in the slalom course such as from G3-G4-S1 to G5-G6-S2. This time should then be less than 98 seconds.
2. What is the depth of water under each course ?

All the data must be collected and entered in the Course Survey Dossier. This Dossier must then be sent to Water Ski & Wakeboard Canada for review and approval. See the notes later about IWSF requirements.

Conclusions:

This concludes the work that must be done fairly far in advance of the tournament. There are still many tasks that will occur prior to the event but are not restricted by the time frames of the survey.

PRE-TOURNAMENT VERIFICATION

EQUIPMENT PREPARATION

All of the equipment needed for the events should be prepared and ready for the tournament. This will include such things as towboats, towropes, timing equipment, jump, buoys, jump measurement equipment, video cameras, personal computers, audible devices, flags, communication equipment and spare materials and equipment.

This raises an important point. The organizer often will have obtained spares such as buoys, ropes etc. You should ensure that you also check these spares and have them ready for use.

It is very helpful to have the organizer assist you or be available. Very often you will need someone to make some minor adjustments or corrections to the equipment.

All the measurements you take must be recorded in the Technical Controller's Dossier which you should have from Water Ski & Wakeboard Canada. Work carefully, and ensure that all items are properly completed. See Appendix for sample Dossier.

We will now discuss what needs to be done to ensure all the above equipment is ready to use. The following items generally follow the order and contents of the TC Dossier.

Course Inspection:

Generally the course survey is to have been completed and approved prior to the event that you are working. Your task is essentially to confirm that the course(s) have remained within tolerance since the survey was completed. Begin by inspecting the condition of each course and their overall layout. This can begin with a simple visual inspection and may require a boat depending on the layout of the site. Satisfy yourself that the site is still within RC standards even though some time may have elapsed since it was surveyed. You should observe and note the following:

Slalom

1. All guide buoys are in a straight line?
2. Buoys S2, S4, S6 are in line?
3. Buoys S1, S3, S5 are in line?
4. Turning buoys align with their guide buoys? (viewed from the side)

Jump

1. All guide buoys are in a straight line?
2. Buoys A & B align with centre of ramp?
3. Ramp angle is parallel or open to course?
4. Are turning guides used?

Tricks

1. Approximate course length?
2. Entrance buoy spacing measurement?

If you are not re-surveying the slalom course, you might consider taking some measurements of some critical course dimensions. For example measure the width of buoys S1,S2,S5, and S6 and then sight the buoy line as above. The jump course should also be checked. Measure the timing segments, taking care to avoid excessive tape sag, particularly on the 82 meter jump timing segment.

Another technique is to construct a rope triangle from polypropylene rope that will reach from gate to gate and out to the skier turning buoy (for the slalom course). This method can be quite accurate but tricky if you take care in applying rope tension in the water. It is however awkward and requires several helpers.

Finally, check the Trick course. While not critical dimensionally, ensure that it is sufficiently long for faster skiers (36-39kph) and that it has adequate approaches for setting up speed. Do however check the spacing of the buoys at each end of the course is 15m +/-2m. The trick course should be checked for water depth also. If the course is generally shallow, and if the bottom depth changes it could affect the boat/wake performance. It might be worth considering a re-alignment to correct or avoid this effect.

Consider whether any buoys will have to be removed to run an event. This might be necessary where skier paths may be interfered with by buoys from a different event. This will often occur where slalom and jump course are close together or even overlap. If buoys must be removed, how will this be done and what assurance is there that they would be replaced in the original location?

Have the towboat driver run passes in each course and observe any backwash conditions that may exist. Review these with the Chief of Competition and determine whether they can be overcome in some way or will be a tournament condition. You might discover, for example that a stop of a few seconds at each end of the course will avoid some backwash on the following pass. Sometimes adjusting the drop time can provide a good solution to minor backwash conditions.

Experiment a bit if you have time to make sure all the competitors will have the best possible ride. Consider also such things as slightly repositioning docks or towers or other objects in the water or on the shoreline to help minimize any backwash conditions.

The Jump Ramp:

The jump ramp must be carefully measured to confirm all dimensions. Measure its width at the top and bottom. Measure its length and its length under water. Remember you must measure as it will be used. It should contain any watering equipment and no one may be on it, except for a watering person if such will be used.

Check to see if the jump is flat. You can do this by stretching a string diagonally across it and measuring the gap between the ramp and the string. If the jump is convex, then you could raise both ends of the string an equal amount, and then deduct this from your deviation measurements. Remember, the deviation is + or - from flat.

Measure the apron lengths in and out of the water and their angle relative to the ramp surface. Inspect the floatation system to ensure it is secure and adequate. Make any fine adjustments you need to ensure the jump is level, and has sufficient length in the water (100 cm.). A similar check should be made of the aprons, ensuring that they will be at least 30cm submerged at all ramp settings.

You should inspect the watering system and the anchoring system of the jump ramp. Check that the anchor lines are secure and the water system functions properly. You should also make sure you know how to adjust the jump for height.

While you are at the jump you should also measure the slope at each setting that will be used in the tournament. Carefully measure and record all lengths and heights on both sides and calculate the slope ratio:

Slope = Height / Length

For example: 1.57 / 6.40 = 0.245, or see Rule Book, Diagram 4.

The slope ranges are:

0.235:	0.232 - 0.238
0.255:	0.252 - 0.258
0.271:	0.268 - 0.274

Make whatever adjustments may be necessary to bring the slope to within the required tolerance. Measure the slope again and repeat this process if necessary. The desired slope is the "actual" or rule specification, i.e. 0.235, 0.255, or 0.271. Make a note of where each setting is to help you each time you raise or lower it. Be careful however to measure each change and record it in the Dossier.

Jump Measurement System (Johnson Meter System, no longer used for RC):

Inspect the jump meter tables to ensure they are secure. They must be solid enough so they can't be accidentally moved. Get the organizer to make any adjustments or add any bracing required to make sure they cannot move.

The tables should also be level and parallel (up and down) and the axis of the sighting arms should be directly in line over each other. (Strictly speaking the tables don't have to be level which can be demonstrated geometrically or mathematically, but things are much simpler if they are.)

Check that the protractors have a minimum radius of 25cm, and are marked in 0.2 degree increments. The upper and lower protractors must also be aligned with each other. Check by sighting on some fixed object.

If the meter tables are already set up complete with protractors and sighting arms, take all the readings described below.

At each meter station make and record all sightings for the masterboard setup. With your tape, measure each distance and record them. The angles should be read to 0.1 degrees and upper/lower readings must be within 0.1 degrees of each other. The distance between the meter tables should be read to 0.01 meters.

Angles to ramp:	**Angles between stations:**	**Angles to Buoy 15MT (E)**
A upper ____	A upper to B ____	A upper ____
A lower ____	A lower to B ____	A lower ____
B upper ____	A upper to C ____	B upper ____
B lower ____	A lower to C ____	B lower ____
C upper ____	B upper to A ____	C upper ____
C lower ____	B lower to A ____	C lower ____
	B upper to C ____	
	B lower to C ____	
	C upper to A ____	
	C lower to A ____	
	C upper to B ____	
	C lower to B ____	

Distances between stations: A to B ____ A to C ____ B to C ____

An additional sighting on a fixed reference point can also be helpful as a check if a problem occurs during the event.

In the event the meter tables are not yet set up, then proceed through the following steps.

Begin by selecting suitable meter locations. They should all have a clear unobstructed view of the jumpers landing area and of each other. A maximum spacing of about 25 meters seems to

work well and the tables should be positioned so that most jumpers can be expected to land somewhere between meter A and meter C. The line of the meter tables should not be more than fifty meters from the skier and in practice they are also best not too close either. It may help to set B behind A and C, particularly if jumpers are expected to land beyond C or short of A.

The meter tables should be stable and secure when placed. If they do line up when you place the protractors on them, set them up so they sight at 0 or 180 degrees between any pair or all of them. Again they may be placed completely arbitrarily, but lining them up makes your job far easier.

When all these are positioned, take your sightings and measurements as carefully as you can. If an automated meter table is used you should confirm that the angle transmitted to the computer or "read" by the equipment is correctly calibrated throughout its range.

The Computer Masterboard:

The traditional manual masterboard has now been replaced for record capability competitions. A computerized system must be used for distance calculations and it must be verified with the Benchmark Test, defined in the rule book. Several approved jump measurement programs are available and suitable for use.

The Johnson three meter system is still the basis for the sightings of the skier landing location, but a computer program is used to mathematically determine the landing location and its distance from the jump ramp.

Basically, this method first uses the site layout information which consists of distances between meter tables, the angles between the tables and also the angles to the jump ramp. From this information most computer programs will calculate the location of the ramp centre based on a X-Y, or Cartesian, coordinate system.

Then as then angles to each skier landing is sighted, these angles are input to the program. From this the program calculates the coordinates of the landing location and then the distance from that point to the jump ramp. Special provisions are also made to resolve the error triangle that usually occurs in determining the final landing location. This is done using the inscribed circle method.

The inscribed circle is simply the largest circle that can be drawn inside the error triangle, such that it touches each side of the triangle. The centre of that circle is the landing location. When this circle becomes too large, then the computer program must also decide whether any particular sighting angle was in error, and which combination produces the best result.

To begin, carefully enter all setup data and sample angles to confirm consistency with the Benchmark. You will find the Benchmark data in your Rule Book, or in the Appendix of this manual. Enter these manually, beware of automated tests! The results *MUST* be the same. Even slight variations are unacceptable since the benchmark specifically tests a variety of situations that may occur in an event. You must record or print these results and include them with the Dossier.

Once you have confirmed the benchmark, then enter your actual site data and confirm that your readings are correct. If your error triangles are too large, re measure and/or correct until the masterboard setup is satisfactory. The error triangle must be smaller that 0.15m (inscribed circle method). This may require several trips to the sighting tables to confirm and re-confirm your measurements. Take time to be accurate, it will save you time in the end!

Another item you may run into is an electronic connection from the meter tables to the computer doing the distance calculation. If this is used, check that the angles the computer receives is the same as the actual sighted angle at the meter table. This corresponding relationship must also remain throughout the meter's protractor range.

The Manual Masterboard:

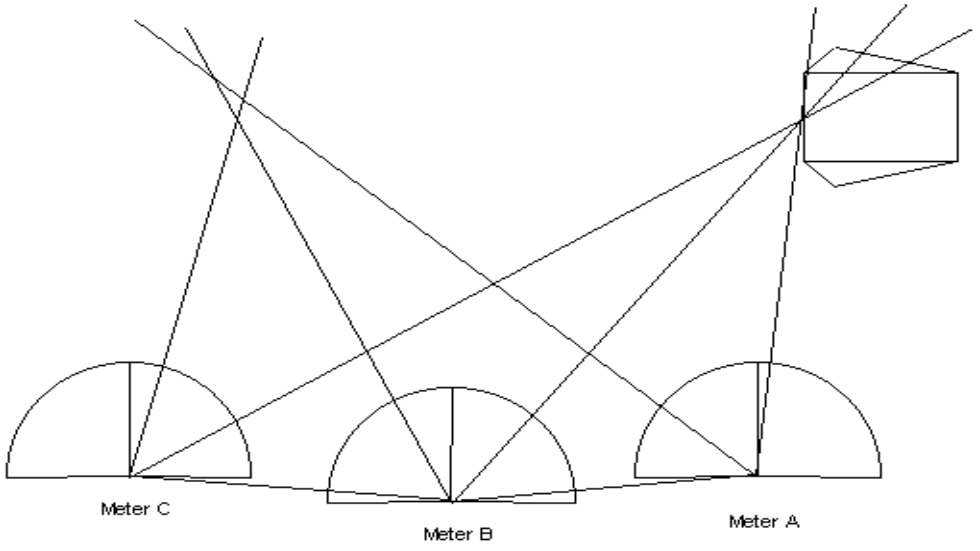
As Technical Controller you should also be very familiar with the manual masterboard, how to set it up, and how it works. While these are not adequate for Record Capability events, they might be useful for backup. Understanding this will help you to troubleshoot set-up problems and will help you have an understanding of the principles of the system. To set up a manual board, you will need the following materials:

1. Three protractors
2. A masterboard grid
3. A tape measure or ruler
4. Some string or thread and weights
5. Some tape and thumbtacks
6. Table top or sheet of plywood

We will assume you are using a standard metric (1cm=1m) distance grid.

The simplest situation is where all three meter tables lie in a straight line and their 0-180 line also lines up with that baseline. Then you can very easily measure and set up the board. If they are not straight then the following description will apply.

JUMP METER LAYOUT DIAGRAM



Begin by placing one protractor (meter A) on a table and secure it with tape. Measure along the angle sighted from A to B according to the scale (1cm=1m) to find the centre of protractor B. Tack the centre of B and rotate it until the angle from B to A is correct. Tape this protractor down. Now measure along the sighting angle of B to C and then tack the centre of B at this position. Again rotate C until the angle from C to B is correct and then tape it down.

Check that each protractor is correctly placed. Attach a string or thread to the tack at the centre of each protractor and draw the string out at the angles for each meter to the jump. These lines

should intersect very nearly perfectly giving you the scaled location of the jump top centre. Tack the jump distance grid at this point and position the grid so its position relative to the protractors is roughly similar to the actual site.

If your thread sight lines do not intersect, then double check each measurement and angle. You may have to go back out to the meter tables and double check those measurements to ensure you have them right. (Patience is helpful!)

Video Jump Measurement:

Description:

Recently, measurement systems using video cameras in some configuration have begun to see more widespread use are mandatory for Record Capability and World level events. These have become popular because they can be very accurate, repeatable and require fewer people to run the event.

One of the most commonly used is the *Corson* Video Measurement System which uses a video camera or cameras which view a predetermined landing area. The landing area is defined as a box or rectangle bounded by marker buoys whose location is surveyed, relative to the jump. The image of the skier landing is then captured on a computer screen and the point of landing contact is marked by a cross-hair or cursor. Then, using techniques of photogammetry, the landing point is calculated and the resulting distance to the jump.

Since the field of view of one camera is limited, one generally sets it up to view a landing range length of about 15-25 meters. In general, mounting the camera higher and farther back widens the range and accuracy of measurement. If landings are expected throughout a long range, then several cameras should be used with overlapping boxes or grids as they are often called.

A computer or computers are used to display and capture the image of the landing. Typically they are equipped with a video capture interface card such as a *"Video Blaster"* or with an external capture device connected to a USB or Firewire port . The image of each landing area or grid should show the four buoys surrounding the area. Since the four buoys seen on one screen have a known location, a calculation can be done to find the landing point within that box. The technique takes into account the perspective of the camera's view and compensates for it in the calculation.

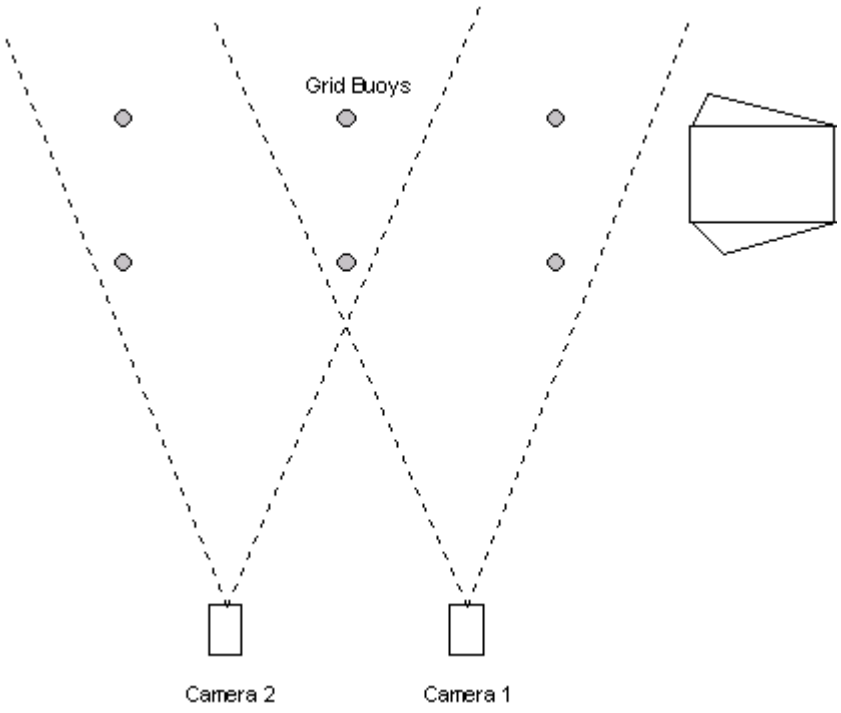
On another note, at the present time, the landing point of the jump is determined by marking the first point of contact (the tail of the ski as it touches the water). It has been empirically shown that this point is 2.1 meters back or behind of the traditional "plume" point observed in the Johnson meter type of jump measurement. For now at least, this 2.1 meters is automatically added to the result so that it will coincide with other previous measurement systems.

Video Tape Recorders should also be used, in line, between the camera and the computer to provide a backup, in case the image of the landing is not captured on the computer. This allows the operator to play back the tape and attempt again to capture the skiers landing.

Be aware also that other techniques are also being developed for measuring jump landing distances. Each generally use a video camera system of one kind or another together with a computer and a software program doing the calculations.

Review the measurement system to be used. If you are not familiar with the system to be used, take some time to familiarize yourself with it and its operation.

VIDEO JUMP MEASUREMENT DIAGRAM
(Corson Method)



Checking the Video Setup:

Inspect the camera mounts and towers to ensure they are stable and secure. Check that any cabling from the camera tower or mount is secure and safe from disturbance from anyone walking around the area. At the masterboard location, check that any VCR's to be used are connected between the camera and computer and that sufficient blank video tape is available.

When the equipment is powered up, the image should fill the lower part of the screen and the four grid buoys should be clearly visible. Review the site survey data to ensure all the grid buoys have been surveyed, and that their position has been calculated. This data will be required for the program, which can be obtained from the internet sites for waterskiing.

If the computer has been set up you can check the measurement to a known point such as the grid buoys and better, a temporary buoy which should be set to provide a sample measurement. This buoy should be surveyed as a formal check of its distance from the ramp. If you are unfamiliar with the system, review it with someone who set it up there to satisfy yourself of its accuracy. Use the software's checks for determining the accuracy of the setup.

Towropes:

The towropes will require some preparation for the events. Begin by ensuring that you have two or three slalom towropes c/w cutoff loops, and two or three jump towropes. These should include handles. Inspect these ropes for their overall condition. Watch for anything that may affect their strength. If they are not new, they must not show excessive frays, or even sun faded colour that can severely weaken the ropes. It is also worth checking to see whether the supplied slalom ropes have enough shortening loops for the expected level of competition, perhaps even down to 9.75 meters?

If the ropes are new they must be pre-stretched to pull knots out tight, reduce their elasticity, and bring them to their design lengths. You can do this in a number of ways. The best method is to actually use the towrope for skiing for a while. Another method is to hang them up by one end with a weight of at least 50-100 pounds for several hours (not very effective), or easier yet tie one end to a solid stationary object and the other to a car or truck and pull it out tight for thirty minutes (This method is not all that effective either). Be careful not to over stress or break the line.

A word of caution, if you set up a hard pull for a short period of time, ensure your safety if a break occurs. You should also use another short piece of rope as tie-offs for the ends. Do not tie the towrope itself into knots or around sharp corners or objects. This will stress and weaken it. NEVER apply excessive tension for any length of time.

Rope Measurement:

You must measure all the ropes at all loops to ensure they are within tolerances for the event. If the ropes have been stretched, allow them to "rest" (no tension) for at least thirty minutes before measuring.

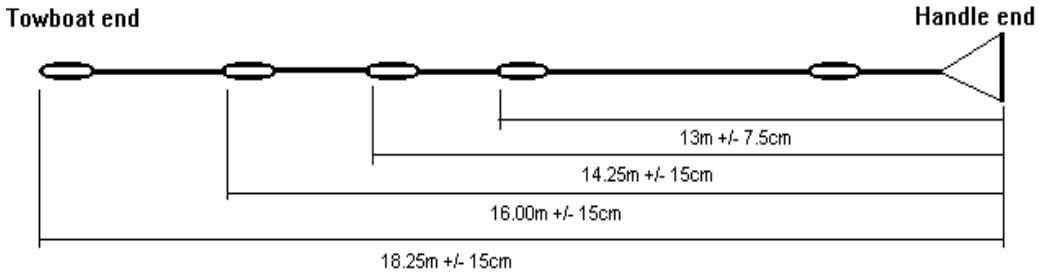
To measure the ropes you will require a spring scale, such as a fisherman's' scale, and a metric tape measure. Have someone hold one end of the rope and tape measure or anchor the end to something solid. Place the scale hook into the loop to be measured, and pull the scale to a tension of 20kg. Measure to the inside of the loops. Take care to sag the tape measure the same as the rope.

Carefully record all the measurements, and mark or tag each rope so you can uniquely identify them later. Replace any ropes which are out of tolerance and cannot be adjusted. You may be able to combine other sections of segmented lines to make up a rope that is within tolerances. Make sure they are correct. To use a rope that is not within tolerances may disappoint some skier that thinks he/she may have set a record. In fact you should avoid using a rope that starts on the long side of the tolerance. Such a rope is sure to end up out of tolerance on a record pass.

It is also worth re-checking the slalom ropes later in the tournament if they are to be used for several days. It is common for them to stretch and gradually lengthen after some continued use.

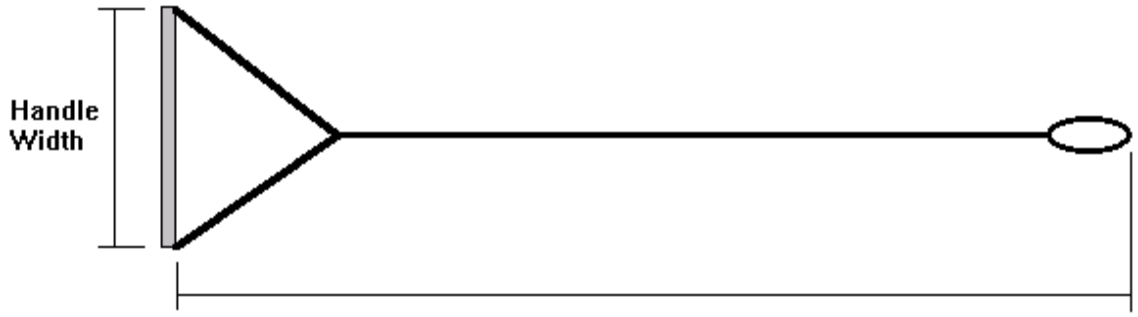
Making adjustments can be a bit tedious but it is often possible to correct for minor deviations. If lengthening, be aware that a change to one section of a slalom rope will affect over segment measurements. A common trick for minor shortening is to insert another piece of rope inside the line. A rule of thumb is that about 50 cm. of rope tucked inside will shorten the line by about

2-3 cm. If your rope is only a little short throughout its sections, a little use in practice could possibly bring it in to tolerance.



Typical Towrope Measurements
(Not all loops are shown)

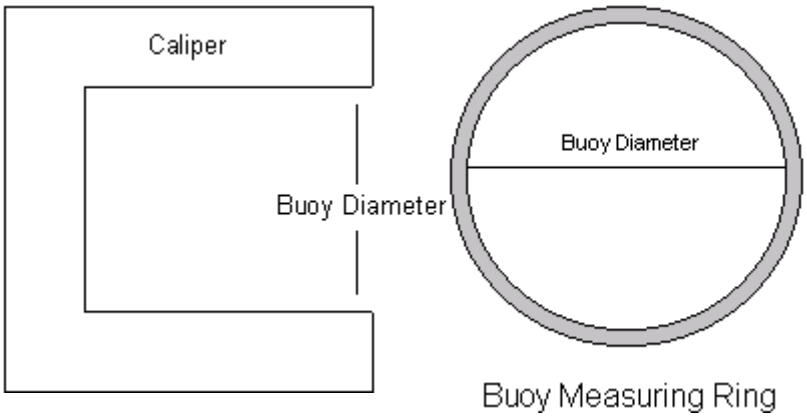
Handle measurement, particularly for skier supplied handles must also be confirmed. A system of measuring should be set up at the starting dock to check each handle before skiing. A variety of devices could be built to help but someone must be assigned the responsibility to do the checking of skier supplied handles.



Handle Section

Buoys:

The slalom and gate buoys must be measured to ensure they are correctly sized and are the correct height out of the water. This is easily done by building a simple caliper or template of light plywood. Another good method is to use a rope loop or ring that equals the desired circumference and simply slip it over the buoys. This device can tell you instantly whether or not the buoys are correctly sized and anchored. The rope loop method is also useful if the buoys are not spherical. The remainder of the buoys may be visually inspected. Cylindrical guide buoys are often used and should be checked for height out of water and for the boat path width between them.



Buoy Measuring Ring

Trick Releases:

If these are tournament supplied, inspect and test them to ensure they operate properly and safely and are correct for the tow bar on which they will be mounted. Otherwise you may damage the boat, or worse, injure a skier.

Flags:

Check for suitable red and green flags, in acceptable condition, for use in the towboats.

Timing Equipment:

Each piece of timing equipment must be checked for proper operation and for accuracy. This should include any stopwatches, and any automatic timing equipment that will be used in the event. The timing equipment must be read to a precision of 0.01sec. Accuracy may be tested in one of the following two ways:

The best test for accuracy that can be done without expensive test equipment is to tune to short-wave radio station WWV or the NRC time signal and run the timing equipment for thirty minutes.

If you start and stop the time manually at thirty minutes you can read the difference between your timer and WWV or the NRC and calculate the accuracy. Thirty minutes is sufficient to reduce the effect of manual start/stop error to much less than one part in 20,000. This is equivalent to ensuring timer accuracy to within 0.001 seconds in 20 seconds.

> For example: After thirty minutes of NRC time, your timer reads 30:00.40. Thirty minutes equals 1800 seconds.
>
> (1800 - ((30 x 60) + 0.40)) / 1800 = 0.00022
>
> This equals an error in 20 seconds of 0.0044 seconds.

This is better than the rule requirement, but is the only way to ensure that your watch is as accurate as someone's in Australia or any where else.

A second, more popular test is to start two watches by tapping their start/stop buttons together and then similarly stop them at about twenty seconds and compare them. You should be able to have them read the same within less than one-tenth seconds. Try several watches, comparing each to one "standard" watch. All should be consistent.

Note: If officials use their own watches, these should also be checked before they are used.

Automatic timing systems, while generally quite accurate, should also be tested. In addition, their operation can be problematic. Many of these systems rely on a magnetic triggering system and can often be affected by stray fields created by devices such as radio transmitters, boat ignition systems, and just about any other electric (or magnetic) device. You may want to test these timing systems in the boat to ensure they are working reliably. Pay attention to boat paths in the jump course because long distances between buoy located magnets and the timing system pickup may affect the system's ability to trigger. If you have problems, you should check the manufacturer's recommendations for their installation and use.

Video Equipment:

Check that all video equipment is available and working properly. Check that the locations provide suitable views of the courses for both Slalom and Tricks.

Check that sufficient video tape will be provided, and that in the event you will require a copy for a record application, how you will get that tape.

For the Trick event, the cameras must located mid course, at least 3 meters above water. The camera should provide a view of the event that is similar to that of the judges' view. The camera must also be able to record the audible device for course timing. For World Record Capability in tricks, the camera must provide an on screen timer. There should be provision for playback for the judges in case they need to review any trick passes during or after the event. The best situation is a quiet, private room equipped with a VCR and TV for playback.

For Slalom, the cameras must be placed at both ends of the course, provide a clear view of the boat path down the centreline, and have at least an 8x lens. If a camera with a high power lens (at least 24x) is available, a view from one end is sufficient. A high ratio or high power lens must be optical. Some cameras offer digital zoom features, but these do not generally provide adequate resolution. The end-course video cameras must be mounted on a tripod, on the course centreline and have their lenses set to provide a clear view of the entire boat path including the boat guide buoys. The best guideline for zoom is to have the near gate buoys fill the screen to about 1/3 its width, diminishing to about 1/6 width at the far end. Further reduction is not adequate for accuracy in determining boat path.

Trick Audible Devices:

Two must be available and properly working so that all judges can hear them. They must also have different, distinguishable sounds. If they have a semi-automatic timing device, verify the twenty second interval with your "standard" watch. This may be difficult if it has a crude manual start button. Take care here to be accurate. A start of time signal must also be provided, but this could be as simple as the person serving as timer saying "start", as long as all the judges can hear this. For record capable events a semi-automatic timer is required. This means the time is started by a judge(s) and then automatically sounds a horn or other device when the pass time has elapsed.

Towboats:

The towboats will generally have been approved in advance by the tournament sanctioning body (WSWC). You should however check that they are the approved boats, and that there are no modifications that may compromise the rules or event. If the boats are different from those which were approved, you should consult with the Chief of Competition to determine if any action may be necessary. You should run the boats in the course(s) and verify that the speedometers are working properly. Test them at 55kph using the timing charts in the rule book.

Complete the towboat check for the Dossier. Record all required observations carefully.

Speed Control Systems:

These are now required for Record Capability Tournaments. Several systems are in use, but fundamentally their purpose is to provide driver independent control of the speed to ensure that "actual" speeds/times are achieved and that each competitor receives a similar pull or ride. This is not simple, however the system should be checked that it is properly installed and that it is functioning properly. Note the software version in use for the system.

Communications:

Briefly review the supplied communication equipment for the officials. Ensure there is sufficient working equipment and spare batteries for all events.

Experience has shown that VHF-FM or UHF-FM portable radios work best. They should have an RF power output of at least one watt. If Citizen's Band equipment is to be used, try to find which channel may experience the least interference from other local users. In either case check that someone will make sure that charged or new batteries will be available each day. Some sites are equipped with a hard wired system providing communication between the various judging locations (except perhaps the boats). This system should also be tested to ensure it is working. Check if a backup system exists, and that it also works properly.

Another surprise that often occurs is interference between radio communications equipment and other electronic equipment used on the site. Most problems usually occur in one of two places. The first, frequently encountered, is the radio affects any electronic timing equipment, particularly timing pick-up sensors which use magnets. The second system affected may be computers that are used for jump distance calculation or for scoring.

Each of these should be tested and any existing problems resolved.

Slalom Towers:

Check each tower to ensure they are properly located to provide a clear view of the course. They must be at least 3 meters above the water level at eye level. They should be placed, one at each end of the course, opposite the number two and five buoys so a good view of the entrance gate is possible. The ideal location will vary somewhat depending on the caliber of skiing. If the towers are not well located and cannot be moved, advise the Chief of Competition of this so he/she can act accordingly.

The diagram show a recommended positioning for slalom judging towers (borrowed from IWSF Homologation Manual). The position puts the line of sight from the tower to the centre of the gate at about a 45 degrees to the centreline of the course.

Trick Judges Towers:

Check these towers or stands to be centrally located relative to the course and at least 3 meters above the water. They entire tricking area should be visible to the judges from this location. The tower(s) should allow sufficient space between the judges to facilitate independent calling of the tricks (the judges should be able to work without hearing each other).

Verification of Computer Scoring Tools:

If the event organizer or calculators are planning on using a computer and software to assist in scoring, this should also be tested. This is particularly important if the software has not been previously approved for use.

Several items should be reviewed as a minimum. Obtain the assistance of the Calculator, or someone familiar with the program(s), if you are unfamiliar with the software to be used. Basically you want to ensure that those scores that are calculated, such as multi-round totals, pass scores, overall scores, are the correct results.

Do a check of any automated scoring such as:

1. If only the final slalom pass is used as input, confirm the correct total is calculated.
2. If trick passes are added by the program, confirm that the individual trick scores are correct, and check to see that repeated tricks are not re-scored.
3. Check the overall scoring calculations by entering a couple of sample skiers in three events and compare with a manual calculation.

IWSF Homologation Requirements:

In addition to the requirements for WSWC events, you must also comply with IWSF Rules if the event is sanctioned as a IWSF World Ranking List or IWSF World Record Capability. Please close attention to variations in these that may have more stringent conditions for these events.

In addition, the IWSF requires a “Homologation Dossier” to be completed and submitted after the event. This dossier can be obtained (downloaded) from the IWSF website www.iwsf.com. After completion, it must be upload to the IWSF website, following the instructions that can be found there.

Conclusions:

This concludes the pre-tournament preparations. Review your Dossier to make sure you have completed all the required checks and measures and that they have been properly recorded. You will continue use your Dossier throughout the event to record changes in setting that occur. Keep it handy!

DURING THE TOURNAMENT

As the tournament progresses you continue to have a variety of measurements and tasks to perform. Most are maintenance oriented, ensuring that the standards continue to be met throughout the tournament. In addition, the event may have athletes setting new records which must be verified.

Maintenance:

Somewhat mundane, but very important, is minor repair or replacement work. If for example a buoy becomes dislodged or damaged, you must check that its replacement continues to conform to the rules, particularly its exact placement. Assure yourself that this will be possible throughout the event. Record all such activity in your Dossier, describing the occurrence and its repair or adjustment.

If any buoys are moved intentionally for the events check each time they are replaced that the positioning is correct. An example of this may be removing some slalom buoys for the jump event where the jump and slalom courses overlap each other.

Another routine item is jump slope changes. Each change should be measured, checked and recorded by you. Each setting must be recorded in the Dossier.

In addition to the foregoing, the event will sometimes have new pending records set. When this occurs you must be very careful to preserve the integrity of the pending record.

Any pending record performance must be recorded in the appropriate Record Application. While the final responsibility for the Record Application belongs to the skier, much of its input will come from you. All the measurements and checks must be completed for any record to be considered. Each event has specific technical requirements which must be confirmed and met.

RECORDS

Slalom Records:

In the Slalom event, if the possibility of a record performance exists make certain the end course video is being recorded before the performances occur. After is too late. In fact, all passes of a record capable event must be recorded.

Next, if a record performance does occur, immediately remove the tow rope, complete with the handle that was used, and record the time it occurred. The event should continue with one of the spare towropes.

After at least thirty minutes have elapsed since the tow rope was used, it should be carefully measured and its lengths recorded. The "rest" time is necessary to allow the rope to recover from excess stretching. Use the same procedure as before the tournament. Anchor one end, apply 20kg tension with a scale and measure the lengths to the inside of the loops. See the appendix for a sample of the Record Application form. The rope could actually be measured before the rest time is over in the event it comes within tolerance before the thirty minutes has elapsed.

As soon as the tow rope measurement has been confirmed, it may be returned to use in the event.

Obtain the ski that was used and measure its width and length to confirm the 30% width rule. This means the width of the ski must not exceed 30% of its length.

Obtain the event sheets and record all times and judges' scores for the record performance.

Verify what timing equipment that was used.

Finally, identify all the Officials that judged the event and obtain their names, ratings and their signatures to complete the record application form.

Trick Records:

When a pending trick record performance has occurred several checks must occur.

Similar to the slalom event, the ski used, must be obtained and measured to conform the 30% width rule.

The timing equipment that was used must be verified that it was indeed the same system that was previously tested. You should check that it still operates correctly.

Record the skier's scored passes in the application and ensure that the video is available to be included with the application. Include copies of the judging sheets and finally, identify the judges involved, and obtain their names, ratings and signatures.

Jump Records:

For a pending record in the Jump event several measurements must be made. Sometimes, depending on the event schedule, this may have to be fairly quickly so be alert for records that occur.

Usually the most pressing item is to re-measure the Jump ramp. You can wait until the current division is completed, but check it before you raise or lower it before the next event!

You must obtain all the data used to measure the actual jump distance. This will include all the meter readings, and the calculated results. It is also very important record all the details of the masterboard setup, including the meter station angles and distances.

Once again, verify what timing equipment was used and the times that were obtained on the record passes.

As for Slalom, the towrope must be recovered and set aside for thirty minutes before measuring its length. Record the resulting lengths.

Finally, obtain the Official's names, ratings and signatures.

Additional Notes:

A final comment about video tapes, from either slalom end course or particularly the official trick video. These are often a real challenge to obtain for verification of performance records. Many times the absence of a trick video has prevented a skier from getting a trick record. Make certain that you either personally obtain copies or ensure that someone has made a commitment to ensure these are submitted with any record application.

AFTER THE TOURNAMENT

Not much is left to do now. Most importantly, if any pending record performances occurred, ensure that you have collected all the data and materials to support the application. If a video must be copied, follow-up to make sure it gets done as required. While the final responsibility rests with the skier, you are the key person for gathering all the details and measures.

Complete all the necessary paperwork. This will include the Technical Controller's Dossier, any Record Applications, and any reporting of special circumstances such as rule deviations. For World Ranking or World Record events you must also complete the IWSF TC Dossier which can be obtained from the IWSF website. This provides a very useful tool for checking all aspects of the setup and recording them. This document must then be uploaded to the IWSF for review.

This is also a good time to go around and thank the many people who have helped you do your job. Most likely there were a number of local helpers who worked with you during the event. Teamwork is usually the most successful way of achieving a good tournament, so don't forget the team!

At last you're done! You've done a lot of work, paid much attention to detail, but after its all over you will know along with everyone else that your event met all the standards ensuring its integrity and its fairness to all competitors.

Well done !

OFFICIAL'S CODE OF CONDUCT

As an Official, your actions must be consistent with the Code of Conduct:

I shall have complete knowledge of all rules and competition procedures for Water Skiing.

I shall honour all event commitments which I have made.

I shall strive to set a good example of conduct to all, whether competitor, official, or spectator and shall always act consistent with the principles of Fair Play.

I shall ensure the safety of all participants above all. I shall not tolerate any action which may be hazardous to another.

I shall constantly review my work and seek to improve my skills and the standards of officiating for Water Skiing.

I shall render decisions firmly but without arrogance; fairly but without officiousness; and according to the Rules, regardless of the score, the individuals concerned, or the teams represented.

REPORTING - RESOLVING PROBLEMS

If you find circumstances where a particular technical requirement is out of tolerance (before the event) begin by working with the tournament organizer to correct the situation. For example you might require the addition of some floatation or ballast on the jump to adjust its height or length, or you may require that a buoy anchor be shifted to correct its position.

If, ultimately, it is impossible to resolve a technical discrepancy, bring this to the attention of the Chief of Competition. With the Chief of Competition you may have to recognize whether the situation will advantage or disadvantage skiers at this event. If they are advantaged, then clearly the record capability status of the event is compromised; if however the skiers are disadvantaged, the event might still be proceed but perhaps slightly less successful.

Either way, this will surely disappoint the competitors, however the exception(s) to the rule must be reported, as described on the Rule Book, to the Technical Committee. The Chief of Competition will advise competitors, coaches, and teams of the situation, and how it may affect them.

JUMP MEASUREMENT BENCHMARK
(Inscribed Circle Method for Johnson System)

For jump distances and records to be certified, the jump meters must be set up so that the angles read from each station, using the official protractors, to the sighting mark, produce an error triangle with an inscribed circle of less than or equal to 0.15m.

For the setup shown, some examples might be as follows:

Angle A	Angle B	Angle C	X	Y	Triangle	Result
75.9638	48.8141	33.6901	10.0	40.0	0.000	OK
76.0	48.8	33.7	9.99	39.99	0.031	OK
75.9	48.9	33.6	9.94	39.93	0.169	BAD

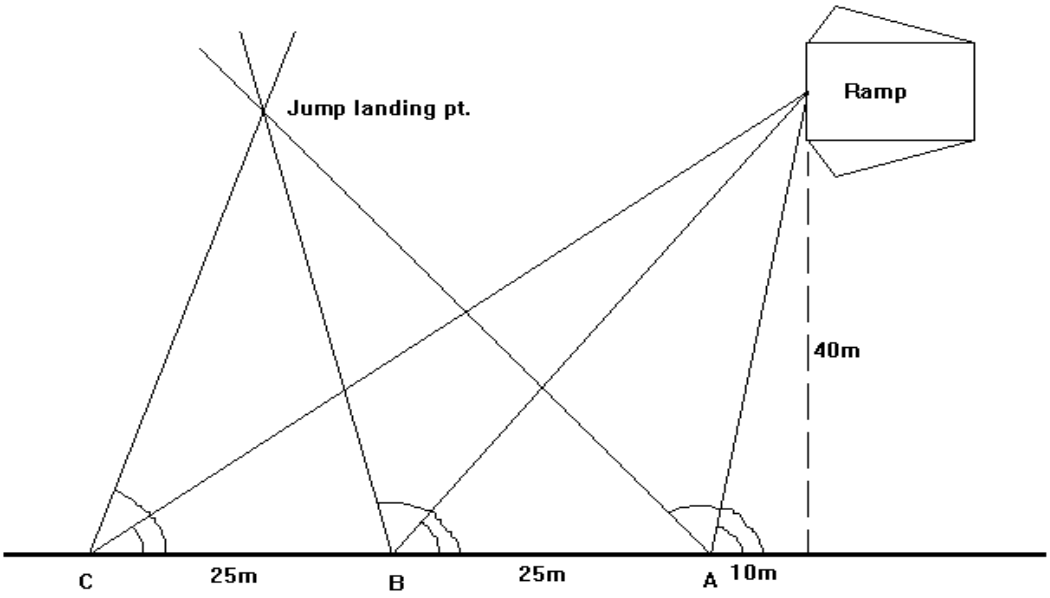
To verify that a computer program is computing distances according to the WSC Rules, the operator must show that it produces identical results with the test cases that follow based on the setup given in the diagram. Note that triangle size is rounded to 0.001m.

Case #	A Upper/Lower	B Upper/Lower	C Upper/Lower	Dist	Triangle
1.	136.6 / 136.6	106.8 / 106.8	65.6 / 65.6	45.5	0.000
2.	136.0 / 136.0	106.0 / 106.0	67.0 / 67.0	45.5	0.560
3.	136.9569 / 136.2431	107.2972 / 106.3028	66.073 / 65.127	45.5	0.000
4.	136.96 / 136.24	107.3 / 106.3	66.1 / 65.1	45.5	0.000
5.	136.6 / 137.32	106.8 / 107.8	66.6 / 65.6	45.5	0.000
6.	137.751 / 137.751	106.8 / 106.8	65.6 / 65.6	45.7	0.600
7.	137.753 / 137.753	106.8 / 106.8	65.6 / 65.6	45.3	0.601
8.	136.6 / 135.8	106.8 / 106.8	65.6 / 65.6	45.5	0.211
9.	136.7963 / 136.7963	106.8 / 106.8	65.6 / 65.6	45.5	0.103
10.	136.7964 / 136.7964	106.8 / 106.8	65.6 / 65.6	45.6	0.104

Case 7. Possible Reride

Longest Vertex	46.1
Shortest Vertex	45.3

JUMP BENCHMARK DIAGRAM

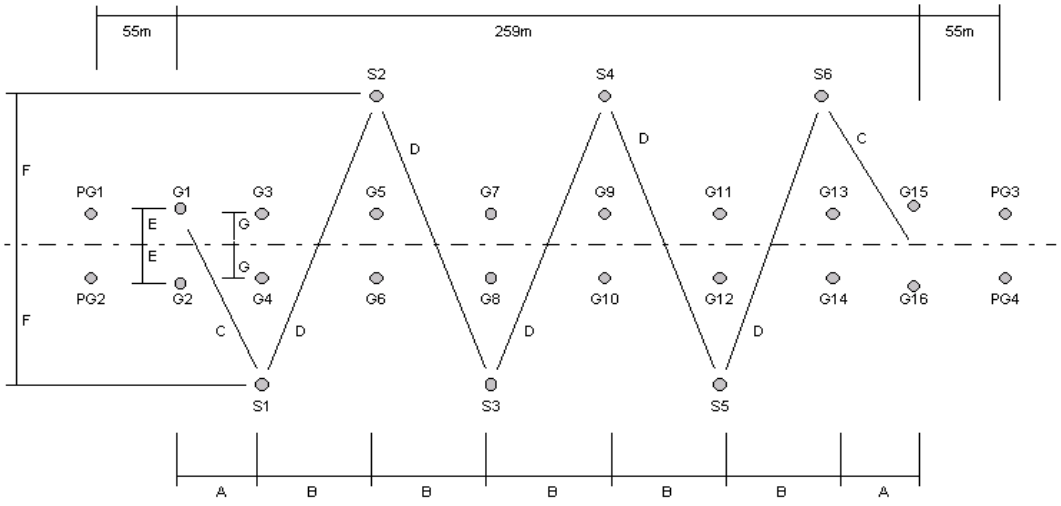


Distance AB = BC = 25m A-B-C is a straight line.

Jump position relative to A: 10m back, 40m out (to ramp center).
Jump centerline is exactly parallel to line ABC.

NOTE: The example shown is theoretical and does not imply that jump setups must conform to this diagram, or that ABC fall in a line.

OFFICIAL SLALOM COURSE DIAGRAM

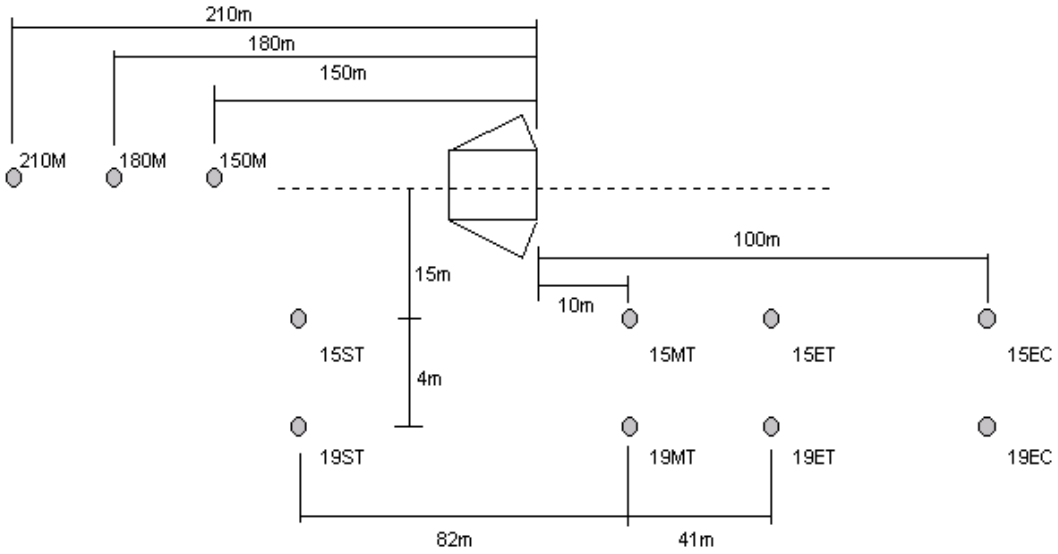


SLALOM COURSE DIMENSIONS AND TOLERANCES

Dimension	**Tolerance**	**Allowable Range**
Overall length = 259 m	+/- ¼%	258.353 m - 259.648 m
A = 27 m	+/- ½%	26.865 m - 27.135 m
B = 41 m	+/- ½%	40.795 m - 41.205 m
C = 29.347 m	+/- ½%	29.200 m - 29.494 m
D = 47.011 m	+/- ½%	46.776 m - 47.246 m
E = 1.25 m	+/- 5%	1.188 m - 1.313 m
F = 11.5 m	+/- 1%	11.385 m - 11.615 m
G = 1.15m	+/- 10%	1.035 m - 1.265 m
Pre-gate distance = 55 m	+/- ½%	54.725 m - 55.275 m

Note: The average of the six measured F dimensions cannot be less than 11.48m.

OFFICIAL JUMP COURSE DIAGRAM



JUMP COURSE DIMENSIONS AND TOLERANCES

Dimension		Tolerance	Allowable Range
210 m (length)	1%		207.90 - 212.10 m
210 m (off-line)		0.5 m	-0.5 m - +0.5 m
180 m (length)	1%		178.20 - 181.80 m
180 m (off-line)		0.5 m	-0.5 m - +0.5 m
150 m (length)	1%		148.50 - 151.50 m
150 m (off-line)		0.5 m	-0.5 m - +0.5 m
100 m		+2%, -10%	90.00 - 102.00 m
82 m		0.5%	81.59 - 82.41 m
41 m		0.5%	40.795 - 41.205 m
19 m		1%	18.81 - 19.19 m
15 m		1%	14.85 - 15.15 m
10 m		10%	9.00 - 11.00 m
4 m		2.5%	3.90 - 4.10 m

OFFICIAL TRICK COURSE DIAGRAM

Sample Survey (Slalom)

SLALOM COURSE VERIFICATION RESULTS
****

Input Data:
Distance AB: 72.985 Distance BC: 79.428

Sighting Angles Input

BUOY	ANGLE A			ANGLE B			ANGLE C		
	deg	min	sec	deg	min	sec	deg	min	sec
S1	38	31	35	9	19	55	5	2	10
S2	110	58	40	38	55	45	18	25	0
S3	154	14	10	69	11	0	18	9	25
S4	148	39	0	112	40	45	47	34	20
S5	162	40	45	147	22	55	77	15	5
S6	157	24	15	144	52	0	109	25	0
G1	23	15	20	9	36	25	5	49	15
G2	25	29	10	10	40	45	6	29	15
G3	50	33	0	15	4	45	8	17	50
G4	52	21	55	16	17	0	9	0	5
G5	120	55	10	31	21	25	13	46	30
G6	118	43	45	32	52	25	14	39	40
G7	146	18	10	71	48	45	23	20	5
G8	144	38	10	72	13	25	24	24	55
G9	154	46	0	119	58	5	42	8	0
G10	153	37	25	118	26	0	43	13	10
G11	158	47	10	141	4	35	77	41	45
G12	157	56	25	139	46	25	77	46	45
G13	161	6	45	150	9	35	114	40	45
G14	160	25	55	149	10	10	113	36	50
G15	162	12	30	153	39	25	129	34	35
G16	161	33	45	152	45	0	128	19	25

Buoy Coordinates and distance to course centreline:

BUOY	X	Y	Error Triangle	Distance
S1	26.993	-11.464	0.008	11.464
S2	67.976	11.490	0.007	11.490
S3	108.950	-11.436	0.003	11.436
S4	149.937	11.495	0.006	11.495
S5	190.965	-11.436	0.003	11.436
S6	231.976	11.546	0.004	11.546
G1	-0.040	-1.208	0.007	1.208
G2	0.040	1.208	0.006	1.208
G3	27.020	-1.149	0.006	1.149
G4	27.006	1.137	0.010	1.137
G5	67.978	-1.138	0.001	1.138
G6	67.960	1.180	0.042	1.180
G7	108.993	-1.117	0.001	1.117
G8	108.993	1.194	0.000	1.194
G9	149.992	-1.133	0.005	1.133
G10	149.957	1.157	0.004	1.157
G11	190.957	-1.128	0.003	1.128
G12	190.959	1.147	0.002	1.147
G13	231.944	-1.112	0.000	1.112
G14	231.967	1.192	0.001	1.192
G15	258.945	-1.235	0.007	1.235
G16	258.897	1.235	0.002	1.235

Slalom Course Buoy to Buoy Distances
(all distances projected on centreline)

G1G3	= 27.060	G2G4	= 26.966
G3G5	= 40.958	G4G6	= 40.954
G5G7	= 41.015	G6G8	= 41.033
G7G9	= 41.000	G8G10	= 40.964
G9G11	= 40.965	G10G12	= 41.001
G11G13	= 40.986	G12G14	= 41.008
G13G15	= 27.001	G14G16	= 26.930
G1G7	= 109.033	G2G8	= 108.953
G9G15	= 108.952	G10G16	= 108.939
G1G15	= 258.985	G2G16	= 258.856

Gate-S1	= 26.993		
S1S2	= 40.983	S2S3	= 40.974
S3S4	= 40.988	S4S5	= 41.027
S5S6	= 41.011		
S6-Gate	= 26.945		

Diagonal Distances Between Slalom Buoys

Gate-S1=	29.327
S1S2 =	46.973
S2S3 =	46.952
S3S4 =	46.966
S4S5 =	47.001
S5S6 =	47.011
S6-Gate=	29.315

Average width of Slalom Buoys = 11.478

Note: Course centreline is taken from midpoint G1-G2 to G15-G16.

Sample Survey (Jump)

```
             JUMP COURSE VERIFICATION RESULTS
             ********************************
Input Data:
Distance AB: 90.000      Distance BC: 82.000

Sighting Angles Input
=====================
BUOY           ANGLE A           ANGLE B           ANGLE C
            deg  min  sec     deg  min  sec     deg  min  sec
============================================================
180M          9   55   34      14   27   40      24   24   14
150M         11    5   22      17    1   38      32    8   14
15ST         11   10   54      22   31   14      90    0    0
19ST          9   53   38      20    5   43      90    0    0
15MT         20   41   44      90    0    0     157   28   46
19MT         18   26    6      90    0    0     159   54   17
15ET         34   45   21     140   19   56     164   32   53
19ET         31   28   37     143   48   24     166   17   35
15EC         90    0    0     159   18   16     168   49    6
19EC         90    0    0     161   33   54     170    6   22
  R1         27    5   23      78   56   17     144   36   34
  R2         25    6   11      77   57    4     146   56   53

Buoy Coordinates and distance to course centreline:
BUOY        X        Y      Error Triangle    Distance
=====================================================
180M     279.998   -16.999     0.000           16.999
150M     250.001   -17.000     0.000           17.000
15ST     172.000    -2.000     0.000            2.000
19ST     172.000     2.000     0.000            2.000
15MT      90.000    -2.000     0.000            2.000
19MT      90.000     2.000     0.000            2.000
15ET      49.000    -2.000     0.000            2.000
19ET      49.000     2.000     0.000            2.000
15EC       0.000    -2.000     0.000            2.000
19EC      -0.000     2.000     0.000            2.000
  R1     100.000   -19.150     0.000           19.150
  R2     100.000   -14.850     0.000           14.850

          Jump Course Point to Point Distances
          ====================================
(Distance Along Centreline)     (Distance To Centreline)
---------------------------     ------------------------
 180M-Ramp  =  180.011          15ST-JCL  =  15.000
 150M-Ramp  =  150.016          19ST-JCL  =  19.000
 15ST-15MT  =   82.000          15MT-JCL  =  15.000
 19ST-19MT  =   82.000          19MT-JCL  =  19.000
 19MT-19ET  =   41.000          15ET-JCL  =  15.000
 15MT-15ET  =   41.000          19ET-JCL  =  19.000
 15MT-Ramp  =   10.000          15EC-JCL  =  15.001
 19MT-Ramp  =   10.000          19EC-JCL  =  19.000
 15EC-Ramp  =  100.000          Ramp-Centreline = 17.000
 19EC-Ramp  =  100.000

            Ramp Angle =  0.00 degrees "Closed"
Note: Course centreline is based on boat course centreline.
      The Jump CL is a line from A through the ramp centre.
```

Other items of interest:

Various other materials are available to assist and guide your technical controller activities. Magazines are sometimes also a useful place to find tips and tricks to things like course setup. Learn from other peoples experiences, it may save you a lot of time and effort.

You might also obtain copies of related or similar materials such as:

IWSF Rule Book
IWSF Homologation Rules and Guidelines
IWSF Homologation Dossier
IWSF Official Water Ski Tournament Manual