Worcestershire **NHS**
Acute Hospitals NHS Trust

EXERCISE TESTING GUIDELINE

This guidance does not override the individual responsibility of health professionals to make appropriate decision according to the circumstances of the individual patient in consultation with the patient and /or carer. Health care professionals must be prepared to justify any deviation from this guidance.

Introduction

Exercise Testing is a widely used tool for risk assessment in patients with coronary artery disease and strong clinical suspicion of coronary artery disease. It is not a substitute for a good clinical history and is not a reliable diagnostic test in patients with a low probability of coronary artery disease as the cause of their symptoms.

This guideline is for use by the following staff groups:
Physicians, Cardiac Physiologists, Rapid Access Chest Pain Clinic Specialist Nurses, Cardiac Rehabilitation Nurses and Chest Pain Specialist Nurses

Lead Clinician(s)

Mrs Julie Caulfield   Countywide cardiopulmonary Service manager

Guideline reviewed and approved Accountable Director on: 20th May 2014

Review Date:
This is the most current document and is to be used until a revised version is available   13TH September 2019

Key amendments to this guideline

Date	Amendment	By:
09/09/2003	Guideline approved by Clinical Effectiveness Committee	
30/08/2007	Guideline reviewed with minor amendments made	Julie Caulfield
30/11/2009	Guideline reviewed with minor amendments made	Julie Caulfield
02/09/2011	Reviewed on 2nd September, no changes required	Julie Caulfield
27/08/2013	Guideline reviewed with minor amendments made	Julie Caulfield
July 2016	Document extended for 12 months as per TMC paper agreed on 22nd July 2015	TMC
August 2017	Further extension as per TMC paper agreed on 22nd July 2015	TMC
September 2017	Document extended for two years as per email from Julie Caulfield, no changes made	Julie Caulfield
December 2017	Sentence added in at the request of the Coroner	

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CONTENTS

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Introduction

Exercise Testing is a widely used tool for risk assessment in patients with coronary artery disease and strong clinical suspicion of coronary artery disease. It is not a substitute for a good clinical history and is not a reliable diagnostic test in patients with a low probablility of coronary artery disease as the cause of their symptoms.

The test may be carried out using either a treadmill or bicycle ergometer, but treadmill testing is used in most circumstances. Use of standard protocols ensures that the results can be interpreted against internationally recognised standards.

Exercise tests are frequently supervised by Specialised Cardiac Clinical Physiologists(CCP) without direct involvement of Medical Staff. Only CCPs who have been assessed as competent may supervise these tests. Assessment of competency must be carried out annually.

There are strict guidelines (British Cardiac Society & Society for Cardiological Science & Technology) to ensure patient safety and appropriate supervision. High-risk patients must always have Medically Supervised exercise tests.

The patient's dignity must be respected at all times and adequate covering should be available and offered to all patients.

Competencies Required

Request forms must be signed by referring physician, or after receiving formal training and assessment i.e. auscultation skills, RACPC Specialist Nurse, Chest Pain Assessment Nurse and Cardiac Rehabilitation Nurse Specialist, to indicate that:

'The patient has been clinically examined to confirm that none of the contraindications exist and it is safe to proceed with an exercise tolerance test'
http://www.scst.org.uk - Recommendations for clinical Exercise Tolerance Testing Pts 4.0

Supervision

Medically supervised tests (Doctor present throughout)
All high-risk exercise tests should be medically supervised. Any patient being exercised with aortic stenosis, hypertrophic cardiomyopathy, unstable angina, recent myocardial infarction, and all others with a recognised potential for developing malignant arrhythmias should be supervised by a Doctor. If there are any doubts over the suitability of a patient for a CCP supervised test, the test should be medically supervised.

CCP supervised tests (low risk)
Low risk ETT is classified as an ETT that excludes the contraindications listed on page 5.

There should be a minimum of a Specialised or Highly Specialised CCP who is fully trained in exercise testing and CPR and is aware that they are responsible for the safe conduct of the test, **and** one trained CCP or ATO present throughout the test and recovery period. (A Rapid Access Chest Pain Clinic (RACPC) or Chest Pain Assessment (CPAN)Nurse may be the second person in attendance).

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The type of supervision required for exercise testing in each patient should be decided by the Consultant responsible for the patient, but if a CCP is unhappy to supervise a test (because of apparent high risk) they should request medical supervision or seek advice from a Consultant Cardiologist.

Protocols for Exercise Testing

a) Standard Bruce

❑ Appropriate for most outpatient exercise tests including risk assessment in stable coronary disease, risk assessment after discharge following myocardial infarction and "diagnostic" tests where these are considered worthwhile.

❑ The Bruce protocol may also be appropriate for low-risk in-patients who initially presented with chest pain and are now pain free for a minimum of 8 hours, have normal ECGs and normal Troponin levels.

b) Modified Bruce

❑ Use for all high-risk tests: e.g. all in-patients after acute coronary syndromes – allows safe detection of a high-risk result at a low workload.

❑ Use for patients up to 4 weeks after MI – with medical supervision.

❑ Use for all patients who have limited mobility.

c) DVLA

Standard Bruce to Stage 3 (9 minutes). Do not continue the test beyond this time.
http://www.dvla.gov.uk/at_a_glance/ch2_cardiovascular.htm

d) Cardiac Physiologist Managed

http://www.scst.org.uk - Reference documents/Stress Testing

Maximum predicted heart rate = 220 – patient's age
(Target heart rate is at least 85% of maximum predicted to allow reasonable interpretation of a test as low-risk or negative.)

THE TREADMILL CAN BE ADJUSTED MANUALLY IF THERE IS DOUBT ABOUT A PATIENT'S ABILITY TO MANAGE ANY OF THE ABOVE PROTOCOLS.

Indications for Exercise Testing

- Risk assessment in stable angina due to coronary artery disease

- Risk assessment after acute coronary syndromes

- Assessment of exercise capacity (e.g. after CABG / PCI)

- Assessment of the effectiveness of drug therapy (e.g. beta blockade)

- Risk assessment on behalf of the DVLA, RAC, CAA

- Detection or assessment of exercise-induced arrhythmia

- Risk assessment in asymptomatic valve disease (e.g. aortic stenosis)

- Risk assessment in younger patients with hypertrophic cardiomyopathy

- Detection of coronary artery disease in asymptomatic patients in certain specific circumstances

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- Pre operative assessment for Abdominal Aortic Aneurysm (The SHO of the referring Consultant MUST either supervise or be in attendance for this test.)

Contraindications to Exercise Testing

a) Absolute contraindications

- Less than 5 days after myocardial infarction

- During unstable angina – patients should be pain free for at least 48hrs

- Uncontrolled cardiac arrhythmia

- Active acute myocarditis / pericarditis

- Infective endocarditis

- Aortic stenosis / HOCM are contra indicated BCS Guidelines for CCP supervised Exercise testing

- Uncontrolled heart failure

- Physical handicap sufficient to prevent safe use of the treadmill

- Non-cardiac illness such as:

    active infection

    uncontrolled bronchial asthma

    advanced renal failure

    severe pulmonary arterial hypertension

    significant anaemia (e.g Hb 10.0 g/dl or less)

- Uncontrolled severe systemic hypertension (>200/130)

- Acquired complete heart block or Mobitz II AV block

- Known left main stem stenosis of more than mild degree

- Patient Weight limits on treadmills: 203 kg / 32 stone

b) Relative contraindications (should be medically supervised)

- Cardiac arrhythmia – assess in individual patients

- Uncontrolled hypertension (200/110)

- Cardiomyopathy (dilated or hypertrophic) – assess in individual patients and discuss with Cardiologist before proceeding.

- History of recent unexplained syncope

- When the test may be difficult to interpret or of limited value and is unlikely to influence the patient's management, e.g. bundle branch block, permanent pacemaker, digoxin therapy, hypokalaemia

Preparation for Exercise Testing

a) Medication

Beta Blockers:
Effective beta blockade will blunt the heart rate and blood pressure response to exercise and may not allow target heart rate responses to be achieved. **However, withdrawal of b-blockers may result in rebound tachycardia, angina and possibly myocardial infarction.** Any decision to stop beta blocker therapy prior to an exercise test must be made by the Consultant in charge of the patient who will evaluate in the individual clinical context. In the majority of patients beta blockade does not prevent adequate risk assessment and exercise testing can provide useful information about the degree of beta blockade achieved.

Digoxin:
Digoxin may cause ST-segment depression on exercise, making interpretation of the ECG during the test difficult. However an exercise test may still allow useful risk assessment if it provokes angina or a fall in BP during exercise.

DVLA requirements:
Some patients undertaking exercise testing for the DVLA and other regulatory authorities will be required to stop anti-anginal drugs, usually for at least 48 hours, before the test. The Cardiologist supervising the test is responsible for assessing in advance the need for and safety of withdrawal of any drug therapy in each individual patient. For example some "anti-anginal" drugs may be needed for control of hypertension and their withdrawal before exercise testing may be hazardous.

b) ECG changes during exercise

The **normal** exercise electrocardiogram.

Normally during exercise the PR interval shortens, the P wave becomes taller and there is downward displacement of the junction between P wave and PR segment. For the purpose of determining STsegment abnormalities, the PR(PQ) segment is used as the isoelectric line. During exercise it is common for the J-point (junction between QRS complex and ST segment) to be depressed but the ST segment is upsloping and returns to isoelectric within 0.04 - 0.06 secs. R wave amplitudes tend to decrease on exercise. T wave amplitude may increase in some patients

Abnormal

ST segment depression
ST segment depression is a non-specific abnormality that may occur in a variety of circumstances:

- reversible myocardial ischaemia due to coronary disease
- acute myocardial infarction
- chronic myocardial ischaemia
- left ventricular hypertrophy due to aortic stenosis
- hypertensive heart disease
- hypertrophic cardiomyopathy
- dilated cardiomyopthy
- myocarditis and pericarditis
- pulmonary embolism

- drugs, e.g. digoxin
- hypokalaemia
- bundle branch block
- pre-excitation (WPW syndrome)
- changes in posture
- hyperventilation
- mitral valve prolapse
- females

However, in some circumstances myocardial ischaemia may develop in the absence of coronary artery disease and, conversely, coronary artery disease may be present without inducing myocardial ischaemia. Thus, the ST segment provides no more than an indirect indication of the presence or absence of coronary artery disease. A "negative" ECG during exercise testing **does not exclude** coronary disease and ST segment depression on exercise may not indicate the presence of coronary disease.

ST segment depression criteria
Horizontal or downsloping ST-segment depression of 1 mm (0.1 mv) measured 80 msec after the J point provides high sensitivity for the detection of myocardial ischaemia on exercise. However the specificity of this finding is relatively low. Using greater degrees of ST depression increases the specificity for myocardial ischaemia but reduces the sensitivity for its detection. Thus, the more severe the ST segment depression, the greater is the likelihood that myocardial ischaemia is present.

Typically, ST-segment depression due to reversible ischaemia starts during exercise and becomes deeper as exercise progresses. The ST-segment usually returns to normal during the recovery phase. The time taken for ST segment depression to resolve after exercise may be a further indication of severity of coronary disease. Horizontal ST segment depression during exercise may start to resolve during recovery and is then followed by downsloping ST segments and biphasic T waves (post-ischaemic change). Occasionally post-ischaemic changes occur during the recovery phase when little or no ST segment depression has been seen during exercise.

Some patients have ST-segment depression at rest, which becomes normal during exercise and reverts to ST-segment depression late in the recovery period. This is a non-specific finding.

ST-segment elevation during an exercise test
This usually occurs in association with regional left ventricular dyskinesia, usually in leads with Q waves from a previous myocardial infarction. When it occurs in leads which do not show evidence of previous myocardial infarction, it usually indicates myocardial ischaemia.

Ventricular arrhythmia
It is not uncommon to observe ventricular ectopic beats during an exercise test even in normal individuals. Often as the heart rate increases, the ectopic beats become less frequent, and they increase in frequency again during the recovery phase. Ventricular extrasystoles which increase in frequency during exercise or which are multifocal, or salvoes of non-sustained VT should be regarded as high-risk features, likley to indicate important myocardial disease or coronary artery disease.

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c) Indications for terminating the exercise test

(Refer to Society of Cardiological Science and Technology – Sample Operational Policy and British Cardiac Society Guidelines for Non-medically Supervised Exercise Tests March 2003)

Absolute indications:

- Patient collapses / Cardiac arrest - commence Basic Life Support. Call cardiac arrest team (2222).

- Limiting angina:
    - At least as severe as that which would normally cause the patient to stop
    - Especially if associated with significant ST-segment depression.

- Fall in systolic blood pressure or heart rate:
    - A fall of 20 mm Hg systolic or more from the previous value. However remember that very tense individuals may show a fall in systolic BP from the resting value as they start to exercise and in these circumstances it is reasonable to continue and to make repeated measurements of BP to check that it is increasing normally with exercise thereafter.
    - A fall in heart rate during exercise is most likely to indicate the development of exercise-induced second or third degree AV block and the test should be terminated and continuous multi-lead ECG recordings made to document the rhythm and its behaviour.

- ST Elevation   >2mm in leads without Q wave

- Dyspnoea
    - At least as severe as that which would normally cause the patient to stop or clearly inappropriately severe for the level of exercise.

- Disabling feelings of faintness or dizziness.

- Ventricular fibrillation or sustained ventricular tachycardia.

- Limiting chest pain, regardless of the presence or absence of ST segment changes

- Inability to continue walking safely on the treadmill for any reason.

Relative indications:

- Fatigue

- Unsteadiness or mild sensations of dizziness

- Marked ST-segment depression (3mm) even in the absence of chest pain

- Atrial arrhythmia (e.g. exercise-induced AF or other tachyarrhythmia)

- Attainment of 85% Maximum Predicted Heart Rate – if able patient should be encouraged to continue

- B Blocked patients attaining 72% Maximum Predicted Heart Rate (Brodie Appendix 4)

- Ventricular extrasystoles especially if increasing frequency with exercise, multifocal, occurring in salvoes.

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- Non-sustained ventricular tachycardia

- Marked elevation of blood pressure >250 systolic.

- Development of exercise-induced LBBB

IF IN DOUBT ABOUT A SITUATION, FOR PATIENT SAFETY, CHECK WITH THE DOCTOR IN CLINIC.

CPR SHOULD BE TO CURRENT RESUSCITATION COUNCIL (UK) GUIDELINES.

Exercise Test Report

Report exercise test results to Consultant on generated Report form, to include symptoms, reason for termination, baseline and maximum heart rate, BP response to exercise, exercise duration, stage attained*, and any significant ECG change. Report to be signed, dated and timed by Lead CCP or clinician in charge of test.

Remember that Bruce stage II is achieved only after completion of the second stage (i.e 6 minutes of standard Bruce, 12 minutes of modified Bruce, stage III after 9 minutes and 15 minutes respectively.

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MONITORING TOOL

How will monitoring be carried out?	Continuous audit
When will monitoring be carried out?	Continuous
Who will monitor compliance with the guideline?	CCPs

STANDARDS:

Item	%	Exceptions
Referrals should meet the appropriate criteria	100%	None
All adverse outcomes to be monitored	100%	None

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- DVLA Guidance on Cardiovascular Disorders January 2003 http://www.dvla.gov.uk/at_a_glance/ch2_cardiovascular.htm

- British Cardiac Society/The Society of Cardiological Science and Technology, Reference documents - Protocol for Cardiac Physiologist managed exercise stress testing 2006 http://www.scst.org.uk

- The Society of Cardiological Science and Technology, Reference Documents - Cardiology Department Sample Operational Policy CCP Managed Exercise Tolerance Tests http://www.scst.org.uk

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APPENDIX 1

EXERCISE TEST CHECKLIST

<u>To be filed in notes</u>

- Patient details correct :   Name, Address, DOB   Yes / **No**

- Protocol correct   :   Bruce, Mod Bruce   Yes / **No**

- Consultant confirmed :   Yes / **No**

- ECG - new abnormality present– refer to Doctor on duty   **Yes** / No

- ECG shown to Doctor on duty if required. Doctor agrees that it is appropriate to proceed with the Exercise Test   **Yes** / No

- BP   Diastolic >110   **Yes** / No

       Systolic >200   **Yes** / No

       Systolic <90   **Yes** / No

- Has the patient been seen by any other Doctor or admitted to Hospital since the exercise test was requested?   **Yes** / No

- Has the patient had any further episodes of chest pain other than their usual angina on exertion?   **Yes** / No

  If Yes, when and how long did it last?

  Was it relieved by GTN?   Yes / **No**

- Current medication

IF ANY ANSWERS IN BOLD TYPE HAVE BEEN GIVEN, THE PATIENT MUST BE DISCUSSED WITH THE DUTY DOCTOR WHO SHOULD DECIDE WHETHER OR NOT TO PROCEED WITH THE TEST.

- Comments

Lead CCP / Supervising Clinician Signature:

Date / Time:

APPENDIX 2

FLOW CHART FOR PATIENTS WITH SUSPECTED ANGINA

Chest Pain

Clinical suspicion
of Angina

| Unlikely | Possible | Definite |

Exercise Test
indicated?

| NO | YES | YES |

Exercise Test

Abnormal / Intermediate
or High Risk

Normal / Low Risk

Coronary Angiography

| Angioplasty | Bypass Grafting | Medical Management |

Dr D W Pitcher, WAHT

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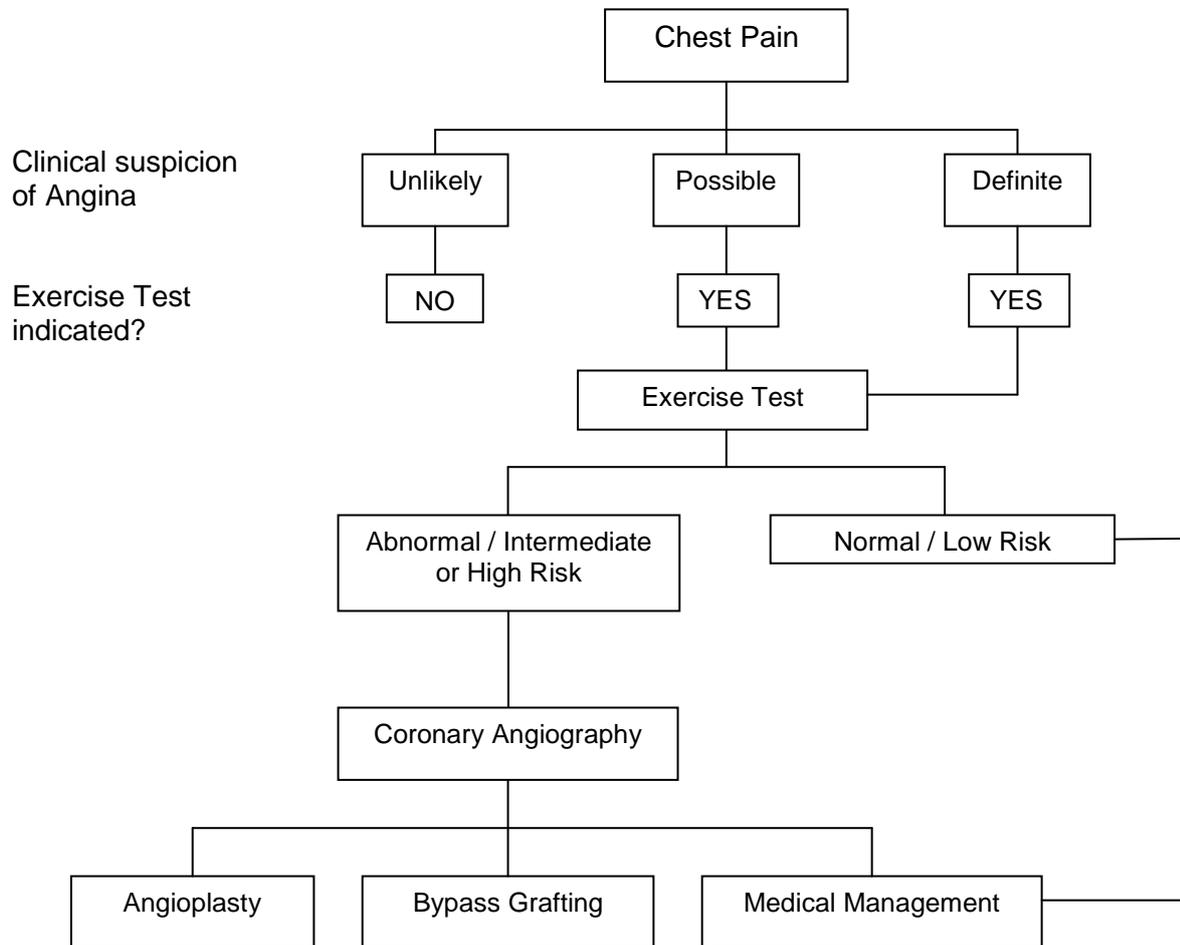
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APPENDIX 3

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EXERCISE TEST OUTCOME

Exercise Test Result   **Action**

These suggested actions are a generalisation and should NOT be regarded as rigid guidelines. The action taken should also take into account the patient's full clinical circumstances and other aspects of the exercise test such as cardiac work (HR or pressure-rate product) at the time of development of positive test result

Exercise Test Result	Action
Angina, ST segment depression or fall in BP before Bruce Stage I (3 min) Extensive ST segment depression (6 Lead) before Bruce Stage II (6 min) Angina or ST segment depression with fall in BP before Bruce Stage III (9 min) VT	Recommend Coronary Angiography (Provided patient is suitable for and willing to consider intervention
Angina or slight ST depression after Bruce Stage I and before Bruce Stage II	Coronary angiography usually appropriate
Angina or ST depression after Bruce Stage II (6 min)without BP fall or VT	Medical treatment initially Refer to GP for secondary prevention
Non specific ECG changes but low-risk test No evidence of ischaemia	Refer back to GP
Sub-maximal test providing inadequate risk assessment	Consider further investigation

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APPENDIX 4

BRODIE SCALE FOR BETA-BLOCKED PATIENTS

Age	Peak Heart Rate	Training Zone
20	144	101 - 122
25	141	99 - 120
30	137	96 - 116
35	133	93 - 113
40	130	91 - 111
45	125	88 - 107
50	122	85 - 104
55	119	83 - 101
60	115	81 - 98
65	112	78 - 95
70	108	76 - 92
75	104	73 - 88
80	101	71 - 86
85	97	68 - 82

Peak Heart Rate = 220 - Age x 0.72 (Brodie)

Training Zone   = 70 - 85% Peak Heart Rate

APPENDIX 5

Worcestershire Acute Hospitals NHS Trust.
Cardio-Pulmonary Department.

Request For Cardiac Exercise Tolerance Test

	For Office Use:
Surname:…………..………………First Name:…………………………….. *Address:……………………………..……………………………………..* *…………………………………..……………………………………* *……………………..……………… GP:………………………………* *Hospital No:…………………………….. Date of Birth:………………………..* *Consultant:……………………..…….. Outpatient/ Ward:………………..*	*Date Received:……………………* *Appt date:………………………..* *…………………………………..…….* *2nd Appt date:……………………* *…………………………………..*

Clinical Details:

BP:

Medication:

___

Tick required box:

ETT at ☐ Redditch ☐ Kidderminster ☐ Worcester

☐ **High risk category** = medically supervised (Ao.Stenosis, HCM ,unstable angina Recent MI < 4 wks., uncontrolled hypertension, all others with a recognised potential for developing Malignant arrhythmia. Refer to Trust policy)

☐ **Low risk category** = technician supervised**. (to be carried out within 6 wks)**

Protocol: ☐ Bruce ☐ Mod. Bruce ☐ Other (state)

Signature**:**……………………………………………………… Date:………………..…………

Surname in Capitals:…………………………………………………………………………………

Incomplete request forms will not be processed