- sanitary flushing
- supply of drinking-water
- firefighting
- air-conditioning
- refrigeration
- ablutions
- prevention of cross-connections
- make-up water
- contingency reserve.

Requirements relating to installation and protection of water storage tanks:

- Tanks must be installed on bases, platforms or supports designed to bear the weight of the tank when it is filled to maximum capacity, without undue distortion taking place.
- Metal tanks (and other tanks when similarly specified) should be installed with a membrane of non-corrosive insulating material between the support and the underside of the tank.
- Tanks must be supported in such a manner that no load is transmitted to any of the attached pipes.
- Tanks must be accessible for inspection, repairs, maintenance and replacement.
- Tanks must be provided with a cover, designed to prevent the entry of dust, roof water, surface water, groundwater, birds, animals or insects.
- Insulation from heat and cold should also be provided.
- Tanks storing potable water should not be located directly beneath any sanitary plumbing or any other pipes conveying non-potable water.

Requirements relating to access to water storage tanks:

- Adequate headroom and side access must be provided to enable inspection, cleaning and maintenance of the interior and exterior of the tank.
- Where the interior depth of any storage tank exceeds 2 metres, access ladders of standard design should be installed and entry safety codes complied with.

Requirements relating to materials used in water storage tanks:

- The internal surfaces of tanks should be coated with a protective coating approved for drinking-water contact applied in accordance with the manufacturer's instructions if the tank is to supply drinking-water.
- Storage cylinders should be made of non-corrosive material.
- Tanks, pipes, heating coils and related fittings should all be of a similar metal to prevent electrolysis, which is more likely to cause corrosion in hot water systems than in cold.
- If steel is used for the tank and piping, it should always be heavily galvanized.

14.5 Labelling and colour coding of non-drinking-water supply systems

Where the alternative supply is a non-potable drinking-water supply, it needs to be clearly and permanently labelled "Caution – not for drinking" at every outlet. Exposed piping must be identified by colour coding (lilac) and permanent markings or labelling. The use of the lilac (light purple) colour on pipes and outlet points has been adopted in some countries to warn that the contents being conveyed within are not for drinking purposes. In the United Kingdom greywater colours are green-black-green, and reclaimed water pipe colours are green-black-green with an additional white band in the centre.

Where the non-potable alternative supply is installed below ground, the service should have a continuous marker tape stating that the pipe below is a "Non-potable drinking-water supply – not for drinking". The marker tape should be installed in the trench immediately above the service. Where piping conveys water downstream from a high or medium hazard, the backflow prevention device shall be clearly and permanently labelled "Caution – not for drinking" along its length. To further assist in identification, outlet points or taps should be painted or coated lilac and a label or sign should be fixed or erected immediately adjacent stating "Caution – not for drinking".

The level of potential cross-connection hazard rating should be classified by use of a method that allows easy identification of the risk level. A commonly used approach is to classify the contained fluids according to levels of risk from 1 (no risk or minimal risk) to 5 (highest risk).

Fluid category 1. Drinking-water supplied by the authority and complying with the plumbing code of practice.

Fluid category 2. Water in fluid category 1 whose aesthetic quality is impaired due to change in temperature or the presence of substances or organisms causing a change in taste, odour or appearance. This includes water in a hot water distribution system.

Fluid category 3. Fluid that represents a slight health hazard because of the concentration of substances of low toxicity. This includes any fluid that contains copper sulfate solution or similar chemical additives and sodium hypochlorite (as found in chlorine and common disinfectants).

Fluid category 4. Fluid that represents a significant health hazard because of the concentration of toxic substances. This includes any fluid that contains chemical or carcinogenic substances or pesticides (including insecticides and herbicides) and organisms that pose a potential risk to health at concentrations sufficiently above drinking-water standards or guidelines.

Fluid category 5. Fluid that represents a serious health hazard because of the concentration of pathogenic organisms or radioactive or very toxic substances.

This includes any fluid that contains faecal material or other human waste, butchery or other animal waste, or pathogens from any other source.

14.6 Situations where there is a risk of cross-connection

There are recognized risks of cross-connection in agricultural and horticultural properties, catering and allied trade installations, domestic installations, health and sanitary service installations, and in industrial and commercial installations. The level of protection required should be determined by identifying the hazards within the premises, then working upstream from each hazard. The water must be regarded as non-potable until a backflow prevention device is provided suitable to the degree of the rated hazard. If a cross-connection has been detected, the pipe system should be taken out of service, flushed, cleaned and disinfected, and the water tested and determined to be safe before it is put back into service. When assessing a potential backflow condition, consideration must be given to the complexity of piping, the possibility that the piping configuration has been altered and the possibility that negligent or incorrect use of equipment has resulted in a backflow condition. The following summarizes the main risks in each of these situations.

14.6.1 Agricultural and horticultural properties

In market gardens, poultry farms and dairy farms there is a risk of cross-connection between the water service and dam water, drinking nipples, fogging sprays, irrigation pipes, antibiotic injectors, cleansing injectors, vertical sprays for vehicle washing or any submerged outlet or hose at tanks or feed troughs.

14.6.2 Catering and allied trade installations

In commercial kitchens, hotels and clubs there is a risk of cross-connection between the water service and water-cooled refrigerant units containing methyl chloride gas or any submerged outlets or hoses that connect to glasswashers and dishwashers, bains-marie, food waste disposal units, garbage can washers, ice-making machines or refrigerators, or hoses supplying water to sinks or other receptacles.

14.6.3 Domestic installations

In domestic installations, there is a risk of cross-connection of the water service to a haemodialysis machine, bidet, water-operated venturi-type ejectors attached to garden hoses when used to empty or clean out wastewater pits, septic tanks, gullies or trenches, storm water sumps, domestic grease traps, or any submerged outlets, or discharge point of the water service in sanitary flushing cisterns, garden hoses supplying water to swimming pools, ornamental ponds, fish ponds, hose taps below the flood level rim of any fixture, or located below ground surface level.

14.6.4 Health and sanitary service installations

These installations include the following risks of cross-connection:

- council sanitary depots: cross-connection between the water service and sanitary pan washers, truck washers and pan-dumping machines;
- dental surgeries: any submerged outlets of the water service connected to chair bowls and venturi-type water aspirators;
- funeral parlours: in embalming areas, the cross-connection between the water service and water-operated aspirator pumps;
- hospitals and nursing homes: submerged outlets of the water service at bed pan washers, bed bottle washers, sterilizers, steam autoclaves, instrument washers, and any cross-connection between the water service and steam pipes, steam boilers or steam calorifiers;
- mortuaries: postmortem areas, submerged water service outlets at autopsy tables, flushing rim floor gullies or trenches, specimen tables and instrument-washing sinks.

14.6.5 Industrial and commercial installations

A common site of cross-connection relates to the use of tanks. Any submerged discharge point of hoses or pipes that supply water to rinse tanks, process tanks and other tanks may pose a cross-connection risk. The industries and commercial installations that carry a risk of cross-connection in these installations include the following:

- abattoirs: cross-connection between the water service and steam pipes, steam boilers or steam calorifiers, and the washing sprays in contact with animal carcasses;
- bleaching works: cross-connection between the water service and steam pipes, steam boilers, steam calorifiers, or any submerged outlets at revolving drum washers, or any pipes conveying non-potable water;
- breweries and cordial and soft drink plants: cross-connection between the water service and the contents of gas cylinders, steam pipes, steam boilers or steam calorifiers, or any submerged water service outlets at drum washers, bottle washers or process tanks;
- butcher shops: cross-connection between the water service and any water-cooled refrigerant units containing methyl chloride gas, or water-powered food-processing machines;
- chemical plants: cross-connection between the water service and chemical pipelines, or the submerged water service pipe outlets at drum washers and process tanks;
- dry cleaners: cross-connection between the water service and solvent stills;
- dyeing works: cross-connection between the water service pipes and steam

pipes, foul water inlet sprays in process tanks, and any submerged water service pipe outlets at vats, tanks and colanders;

- engineering works: cross-connection between the water service and any steam boilers, diesel oil recirculating systems, recirculated cooling water for machines, testing pressure vessels, oil-cooling coils, pump priming, compressed air pipelines and venturi-type ejectors in vehicle maintenance pits;
- laboratories: cross-connection between the water service and any aspirator pumps, fume cupboards, stills, centrifuges, blood-testing machines, air scrubbers, test-tube-washing machines, animal feeding troughs, and high-pressure gas cylinders;
- laundries: cross-connection between the water service and any clothes-washing machines, starch tanks, soap-mixing vats, and recirculated hot water tanks;
- milk-processing plants: cross-connection between the water service and any steam pipes, steam boilers, steam calorifiers, or any submerged outlets at bottle-washing machines, milk can-washing machines, and process chilling tanks;
- oil storage depots: cross-connection between the water service and foam firefighting equipment;
- poultry-processing plants: cross-connection between the water service and any steam pipes, steam boilers, steam calorifiers, or any submerged outlets at feather-plucking machines, carcass-washing machines, offal boilers and process tanks;
- photographic developers: cross-connection between the water service and X-ray equipment, or any submerged outlets at tanks and rinse machines;
- plating workings: cross-connection between the water service and solvent, acid or alkali tanks, cooling coils, steam pipes, or any submerged outlets at tanks and rinse machines;
- tanneries: cross-connection between the water service and vats, drum process tanks or steam pipes;
- wool processors: cross-connection between the water service and lanolin centrifuges and head recycling coils, or any submerged outlets or hoses at vats, drums and tanks.

14.7 Fixture unit calculations for multiple dwellings

The fixture unit concept is a method of calculating drinking-water supply and drainage piping requirements within large buildings where economies may be made in construction costs. Theoretically all pipes should be of such a size as to be capable of serving the fixtures to which they are connected when all other fixtures in the building are being operated at the same time. In practice, the chances of their simultaneous use are remote and the piping design criteria may be relaxed to some degree.

A fixture unit (f/u) value is assigned to each type of fixture based on its rate of water consumption, on the length of time it is normally in use and on the average period between successive uses. Some examples of fixture unit values assigned to the most common fixtures are given in Table 14.3. When these are added their total gives a basis for determining the flow that may be expected in a water or drainage pipe to which two or more fixtures are connected. The total is then reduced by a factor, usually in the order of 0.6 to 0.7, but depending upon the margin of simultaneous use protection necessary under local conditions (Taylor & Wood 1982).

The total number of fixture units connected to each branch pipe is then added, multiplied by the factor referred to above, and the result used to calculate the flow in water or drainage pipes in accordance with tables such as the following examples. If included in, or annexed to, a plumbing code, these tables should be detailed for a larger schedule covering the whole range of fixture unit values to be expected; examples may be found in various national codes.

TABLE 14.3 FIXTURE UNIT VALUES FOR SOME COMMON PLUMBING FIXTURES

Fixture	Fixture units
Bath or shower	2
Bidet	2
Clothes washer (automatic)	3
Drinking fountain	3
Kitchen sink	1.5
Urinal or water closet (with flush tank)	3
Urinal or water closet (with flush valve)	6
Washbasin	1

Source: Taylor & Wood 1982 (p. 153).

From Table 14.4 the size of the water pipes may be calculated using normal design principles (allowing for head loss, friction and other factors). Fixtures using both hot and cold water (such as in baths and sinks) should be assumed to take equal quantities of each for design purposes: a bath would be counted as one fixture unit on the cold water system, and one fixture unit on the hot water. Supply piping would be calculated accordingly, while the total figure of two fixture units would be used to design the drainage piping.

From Table 14.5 the size of internal and external drains may be calculated according to the total number of fixtures discharging into each section, with the proviso that underground drains shall not be smaller than 100 millimetres (4 inches) diameter, and that no internal branch or drain of less than 80 millimetres (3 inches) diameter should carry the discharge of more than two water closets.

An alternative to the fixture unit method for calculating flows is used in some French-speaking countries. This method assigns individual flow values to each

TABLE 14.4 PEAK WATER DEMAND OF PLUMBING FIXTURES

No. of fixture units	litres per second	US gallons per minute	UK gallons per minute
5	0.23	3.65	3.04
10	0.34	5.39	4.49
20	0.54	8.56	7.14
50	1.13	17.94	14.93
100	1.67	26.51	22.07

Source: Taylor & Wood 1982 (p. 153).

TABLE 14.5 MAXIMUM LOADS FOR HORIZONTAL FIXTURE BRANCHES AND BUILDING DRAINS OR SEWERS

Diameter of drainpipe		Fixture branch	Building drain or sewer			
mm	inches	Min. slope 2% (1 in 50) f/u[a]	Slope 0.5% (1 in 200) f/u[a]	Slope 1% (1 in 100) f/u[a]	Slope 2% (1 in 50) f/u[a]	Slope 4% (1 in 25) f/u[a]
32	1.25	1	—	—	—	—
40	1.5	3	—	—	—	—
50	2	6	—	—	—	26
65	2.5	12	—	—	—	31
80	3	32	—	36	42	50
100	4	160	—	180	216	250
150	6	620	—	700	840	1000
200	8	1400	1400	1600	1920	2300

[a] f/u = fixture units.
Source: Taylor & Wood 1982 (p. 154).

fixture, multiplies the cumulative flow so obtained by a simultaneous use factor obtained from a nomogram and curve, and selects pipe sizes by reference to precalculated tables.

World Health Organization

WATER SAFETY in PUBLIC BUILDINGS

Version 6 - February 2007

WATER SAFETY in PUBLIC BUILDINGS

Introduction

Extensive experience has shown that inadequate management of water systems in buildings of all types is associated with outbreaks of disease. The building types, water uses, disease outcomes, and individuals affected are each very diverse. The associated health risks can be readily controlled [and at low cost]. However available evidence - both from outbreak detection and from understanding of underlying driving forces - suggests that the overall trend is increasing. The rising trend, preventability and cost-effectiveness of interventions suggest the issue should be considered a [public health] priority.

Building types from which water-derived disease outbreaks have been detected include abc - xyz as well as domestic buildings. With increasing global urbanization the overall exposure of the human population to such buildings is increasing rapidly and in consequence the potential risk is increasing.

Outbreaks and cases of [insert short list e.g. typhoid, cryptosporidiosis, lead poisoning, ...] have been associated with water mismanagement in buildings.

'Drinking water' is a long-recognized cause of water borne disease caused by both pathogens and toxic chemicals arising from ingestion of the infectious (e.g. ...) or toxic agents (e.g. lead, copper, nickel, vinyl chloride, all of which are prone to increase in water between its arrival and use due to the means of its storage and use). There are uses of water in buildings other then ingestion that are associated with disease. Legionellosis arises following inhalation of 'aerosols' and this route of infection has been associated with health care settings and garden centers ... Other health outcomes that may be prevented by achievable improvements in water management in buildings include drowning, scalding...

A significant proportion of such water-borne disease is associated with contamination within buildings. This arises from direct contamination (e.g. pigeon shit into tanks);

indirect (e.g. cross connections between potable water and contaminated water and growth of indigenous microbes (e.g. ???).

The impacts on health of inadequate management of water in buildings is considerable and has in turn significant economic impacts [? expand with some example of economic impacts - costs to people getting ill, costs to health care system, lost opportunity arising from illness (productive and school time lost). In health care settings [add a statistic or link to one of the case studies that 'sells' the scale of impact and cost savings attainable]. Add a sentence on Legionella and impact on tourism.

Different population groups may be especially susceptible to certain water-related hazards and certain building types are therefore of special concern. Important examples include health care environments where growth of Ps aeruginosa is a significant health concern and leads to substantive avoidable costs; care homes for the elderly (scalding; ?, then one more example)

The third edition of WHO's Guidelines for Drinking-water Quality introduced the concept of 'water safety plans' and a 'Framework for Drinking-water Safety' (see box x and insert the simple version as a box - from available materials). The Framework focuses attention on effective preventive management and thereby disease prevention. The Guidelines Chapter 6 deals with the application of the Guidelines in a series of settings with specific reference to 'Large Buildings' such as health care facilities and schools and day care. The Guidelines recommend that 'large buildings' such as these have their own 'water safety plans to ensure the maintenance of water safety within such premises, with the intention that such 'building water safety plans' complement the water safety plans of water suppliers.

In most cultures for buildings (other than private domestic premises ie other than 'owner occupiers') there is a person or institution that bears some responsibility for the safety of water installations. This text, which is a supportive text to the Guidelines for Drinking-water Quality - is intended to support the improvement of such management. Its target audience includes the full range of 'actors' that influence the overall safe management of building water. In addition to 'building managers' this includes [insert list based on chapter titles of section 3].

At the meeting of government-nominated experts that finalized the third edition of the

Guidelines the issue of water safety in buildings was identified as a priority and this lead to a plan of work that lead to the development of this document. It also draws on two other processes and publications: the WHO Guidelines for Safe Recreational Water Environments Volume 2: swimming pools and similar environments; and Legionella in the prevention of Legionellosis.

This document therefore deals with the control of water safety in buildings through the development and implementation of 'building water safety plans' as recommended in the Guidelines for Drinking-water Quality. It addresses all building types [insert essentially the agreed definition of scope]. The list of building types addressed is very extensive [cross reference box in later section with David's long list].

This document does not deal with:
* good practice in plumbing, which is dealt with in a separate supporting document to the GDWQ: 'Health Aspects of Plumbing'
* recycling of water which is the focus of a separate initiative under the 'rolling revision' of the GDWQ
* direct management of water sources (such as wells) by building managers which is addressed directly in the GDWQ

This book is therefore structured in three sections as outlined in figure x

[insert figure showing sections and chapters in a neat flow chart]

Health impacts and other consequences are highlighted through a series of case studies in boxes in chapters

Section 1: Introduction and Health Aspects

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Unbalanced case studies spread as examples over the text matching the respective chapter

1.1 Introduction and Overview of Hazards

Approach to this chapter: we believe there should be a general but short introduction that puts the document into context specifically how it fits into the Water Safety Plan Approach as advocated by WHO in the Drinking Water Guidelines 2004. This is something that it is consistent with all other WSP guidance documents. However, we would suggest that this needs to explain why drinking water quality in buildings has to be handled differently from water supply quality i.e. water suppliers, be they public or private, are organisations who can be held accountable for water safety, sufficiency and quality in the public interest, this is not the case for water within buildings, where the accountability falls to the owner and it is for the building being safe (water being but one of many factors (and not something that the owner can be expected to have a deep knowledge of).

Note: we envisage most sub sections will be a short paragraph, nothing longer.

1.1.1. WSP Context

1.1.2. Definition of building

Definition of Building (in the context of water safety). We will use the definitions contained in a DWI research report authored by WRc for public buildings expanded to include the domestic and developing country context (buildings with no piped supply but standpipes or tanks/containers)

1.2 What is the problem

(short case examples to illustrate each hazard)

1.2.1.Introduction to the concept of a hazard

1.2.2. Microbiological Hazards - Sewage/excrement

Domestic single premises and multi-occupancy (as agreed not aimed specifically at individual householders who would not be expected to have a WSP but to building managers / landlords of either individual or multi-occupancy buildings).

1.2.2.1. Types of system and uses (piped systems; mains and borehole / well for drinking and food preparation, for cleaning; personal hygiene; washing; etc, also hot tubs; swimming pools).

1.2.2.2. Risks associated with domestic drinking water systems (eg untreated water from borehole supplies;; system design; long runs in reticulated systems; poor temp; scalding control; hot tubs and swimming pools

1.2.2.3. Risks associated with domestic hot tubs; pools etc

1.2.3 Microbiological Hazards – growth of environmental organisms

Public buildings (not healthcare) includes schools; offices; hotels; leisure complexes; spa resorts etc

1.2.3.1. Systems and uses piped systems; mains and borehole uses to include large scale catering food preparation; irrigation (in addition to above cooling systems; pools; water features ;grey water ;fire sprinklers; hot tubs / spa pools swimming pools etc)

1.2.3.2.Risks to include intermittent usage; maintenance; management at risk users etc

1.2.4. Chemical Hazards – accidental contamination

Industrial premises

1.2.4.1(Additional systems and uses; including both open and closed cooling systems including continuous use; food manufacture (cross ref to codex)

1.2.4.2 Additional risks e.g; industrial processes with high nutrients / special waste considerations eg plastics factories ;wastewater and reclamation; long systems runs etc

1.2.5. Problems caused by materials in contact with drinking-water

Healthcare premises

1.2.5.1.Systems and uses (in addition to above; dental chairs; hydrotherapy pools; endoscope washers; sonicating baths etc

1.2.5.2.Additional risks; large systems; intermittent usage; at risk populations etc

1.2.6. Chemical Hazards – inadequate maintenance

Buildings for special purposes (e.g. fire stations; pumping stations; laundries) (to discuss)

1.2.6.1.Systems and Uses

1.2.6.2 Risks

1.2.7. Design hazards – Temperature

1.2.8. Design Hazards – exposure

1.2.9. Design hazards – reliability

1.2.10 User hazards

1.2.11 Natural Hazards and disasters

Table 1: Unforeseen events and interventions

Section 1	Section 2	Section 3
Unforeseen Events	Intervention (technical) (preventive and corrective action)	Functional responses
Contamination		
Cross connection	Piping system design Education of plumbers Correct fire hose layout	
Backsiphonage	Backflow protection incl. non return valves Vacuum break Many others… Maintain continuous pressure	
Scale formation	System design and temperature control	
Corrosion	Correct material selection Specific corrosion control measures (incl. Addition of anticorrosion products – evaluation must refer to Legionella spp.)	
Stagnation	Avoid/remove dead ends Check design and operation of pipe loops	Awareness and understanding amongst managers and planning people
System/equipment deterioration		Preventive maintenance Awareness amongst especially hospital managers

Section 1	Section 2	Section 3
Unforeseen Events	**Intervention (technical) (preventive and corrective action)**	**Functional responses**
Do-it-yourself-repairs/ installations		Product information requirements Educational activities targeted on building owners/managers Educating plumbers
Household storage (a la bucket)		
Low level/buried storage		
(raised) Storage tanks open/ faulty	Periodic drainage and cleaning Flushing after (even brief) non-use	
Migration of organics into drinking water	Appropriate material selection	
Intermittent use (clarify meaning closed wards, seasonal towns, hotels fluctuation et al.)	Flushing For larger installations specific maintenance protocols Specific protocols	
Intermittent supply	First option make it not intermittent	
Microbial growth		
Raised temperatures	Insulation / position of pipes in	

Section 1	Section 2	Section 3
Unforeseen Events	**Intervention (technical) (preventive and corrective action)**	**Functional responses**
in cold systems	the building Check cross-connections at the tap	
Stagnation	(same as above)	
Low temps in hot water systems	Insulation Temperature regulation Check design and operation of pipe loops	
Aerosol generation		
Sewage aerosol generation	Water traps in all sewage lines Filters double traps in high risk environment	
Freshening sprays (vegetables and horticulture displays)	Water quality controls, e.g., UV multi-barrier more exacting standard)	
Deliberate sabotage/ contamination	Security	
Natural disasters	, back-up systems	Education, contingency planning, emergency response
Flooding	As above	
Malfunction of Point of Event/ Point of Use	, maintenance and alarms	Training
Tap Hygiene	tap design	Education
Scalding	Design and temperature	
Low pressure	System design	

Section 1	Section 2	Section 3
Unforeseen Events	**Intervention (technical) (preventive and corrective action)**	**Functional responses**
Dissolution of metals	System design and water conditioning	
Delivery by tanker	appropriate equipment	Training
Conditioning systems	Appropriate design	

1.3 Types of buildings and associated water systems, uses and associated risks

1.3.1. Introduction to concept of risk (likelihood)
Overview of piped water systems and design issues; availability of water; effect of water quality e.g. of sources mains v borehole; Systems design and materials; water storage; waste water etc

Types of buildings

Set out below, in no particular order, are the kind of buildings, from a UK perspective, we would consider should be included in considering water safety plans for buildings. The main criteria for inclusion is buildings where people are likely to drink water, consume food prepared using water or be exposed to water for washing, showering etc. It is not proposed that this is an exhaustive list of buildings.

School / College
University
Further Education
Nursery school

Hospital
Clinic
Doctor surgery
Dentist surgery
Residential care / retirement home
Health centre
Nursing home
Childrens' home
Vet surgery
Ambulance station / fire station

Restaurant
Fast food outlets
Hotel / Inn
Hostel

Guest House (bed & breakfast)
Public House / Bar
Café
Campsite

Museum
Art gallery
Exhibition centre
Conference centre
Sports ground
Stadium
Leisure centre
Swimming pool
Health clubs / fitness centres
Dance halls/ nightclubs
Theatre / concert hall
Ice rink
Cinema
Historic building / stately home
Shops
Garden centres

Hairdresser beauty salon
Prison / detention centre
Community centre
Police station
Barracks

Houses
Offices (low rise and high rise)
Factories
Production centres
Workshops
Apartment blocks (low rise and high rise)

Public toilets