Hydraulic / Pneumatic systems

Work plan

- Produce this work plan.
- Sketch an aircraft hydraulic system that includes flaps and landing gear.
- Sketch a pneumatic emergency blow down system to be included in the hydraulic system.
- State which hydraulic fluid should be used in the system and why.
- Explain which materials should be used for the pipes and the seals.
- Describe the operation of the hydraulic system.
- Describe the operation of the pneumatic system.
- List all the safety precautions, which are to be adhered to.

Safety precautions

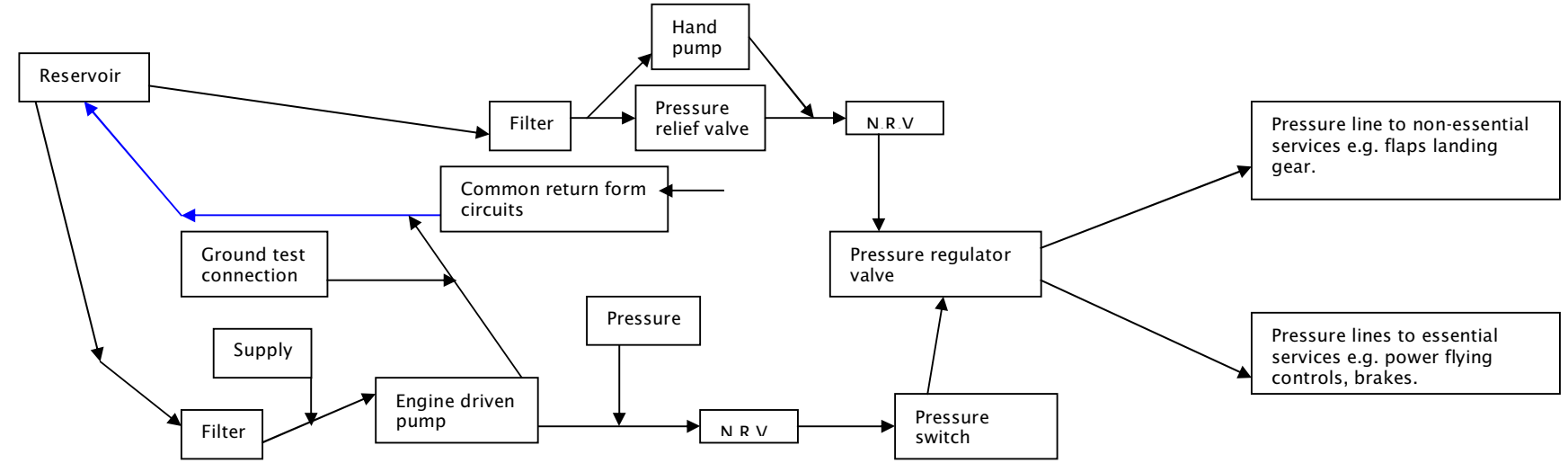
I. Beware high pressure air can kill,
High-pressure air can reach an explosive velocity and can easily maim, blind or kill.

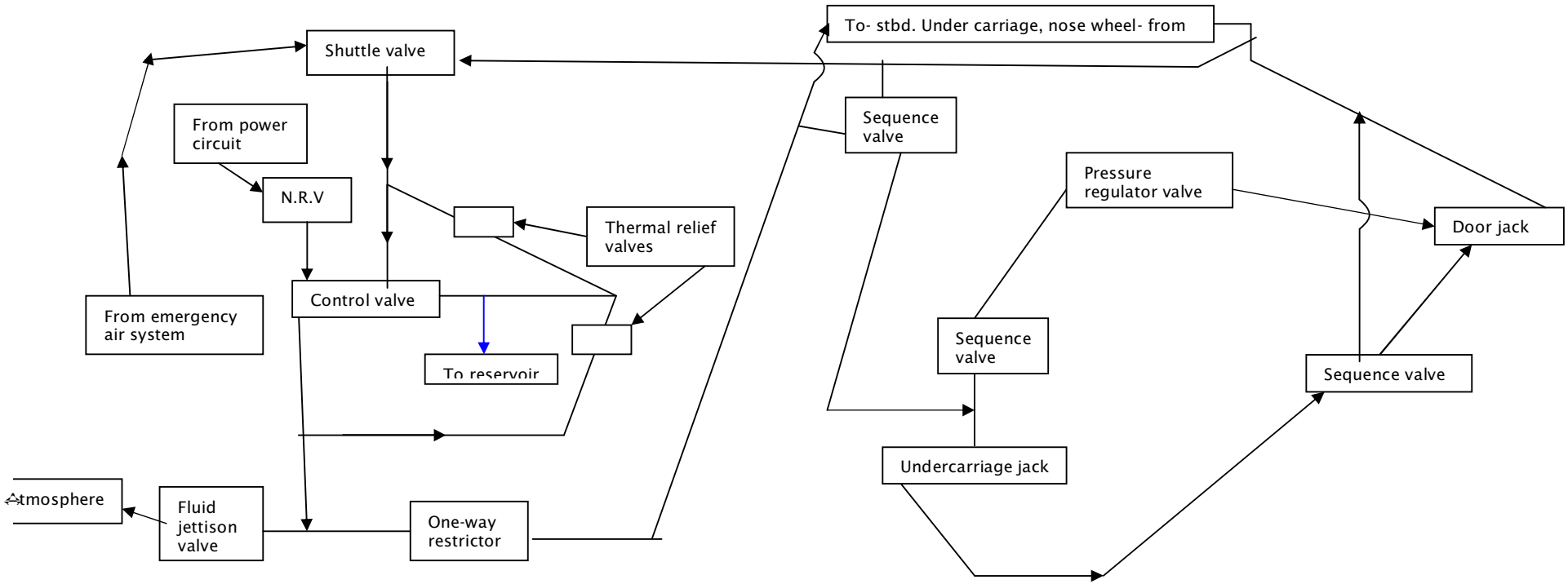
II. When working on high pressure air systems:

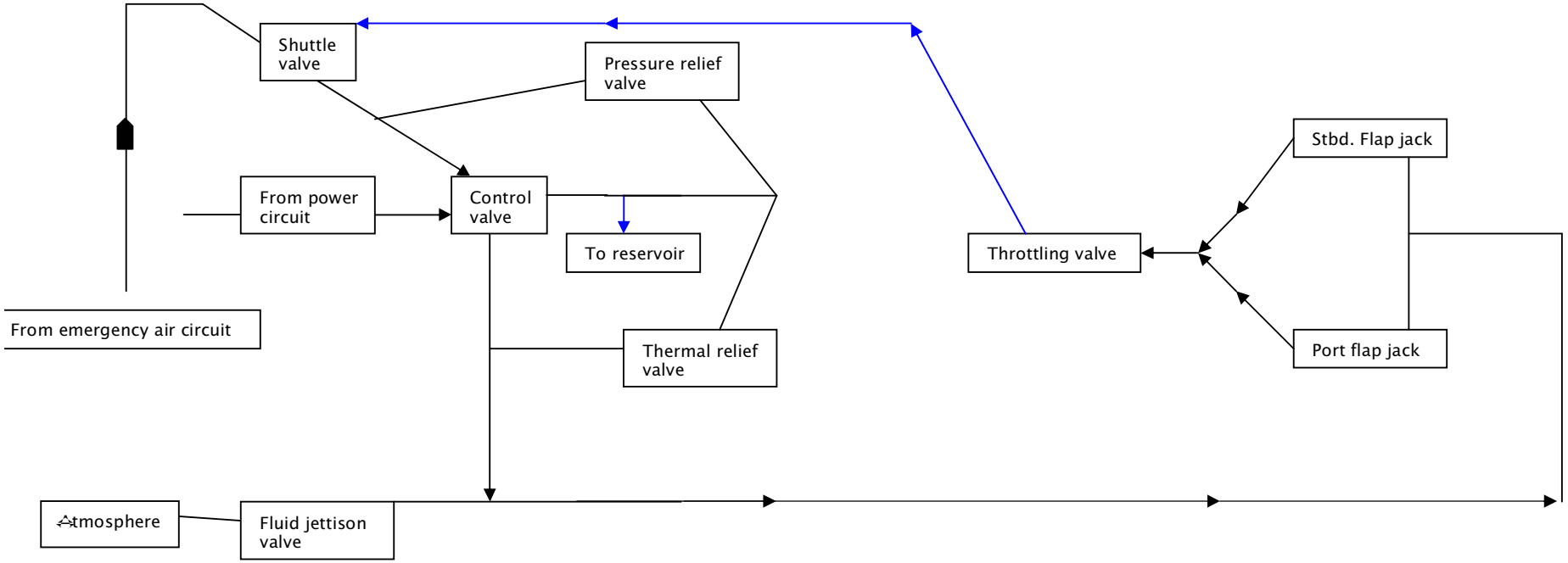
II.II Ensure the system being worked on is isolated or the whole system is totally drained of air.

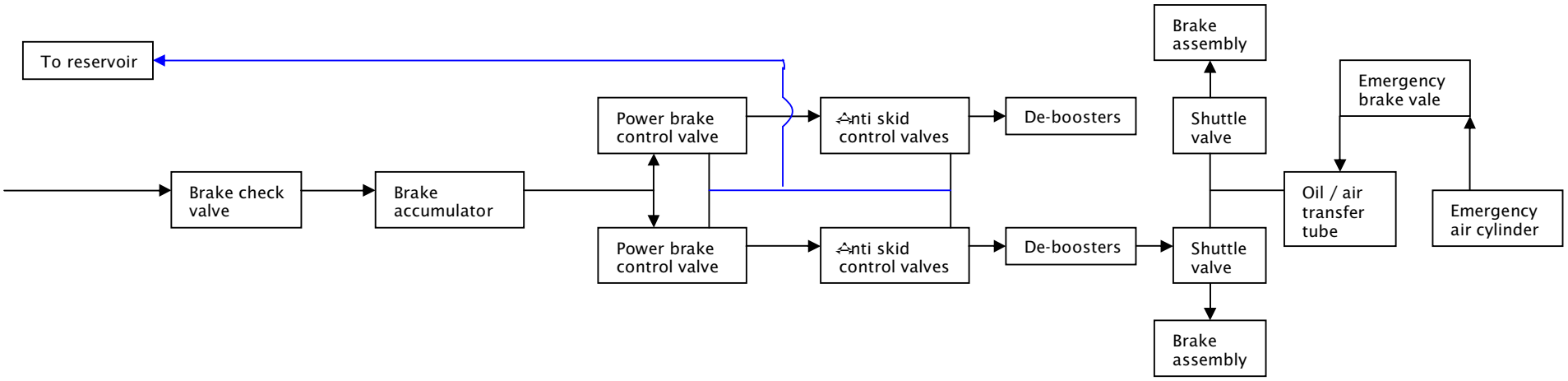
II.III Secure any movable components.

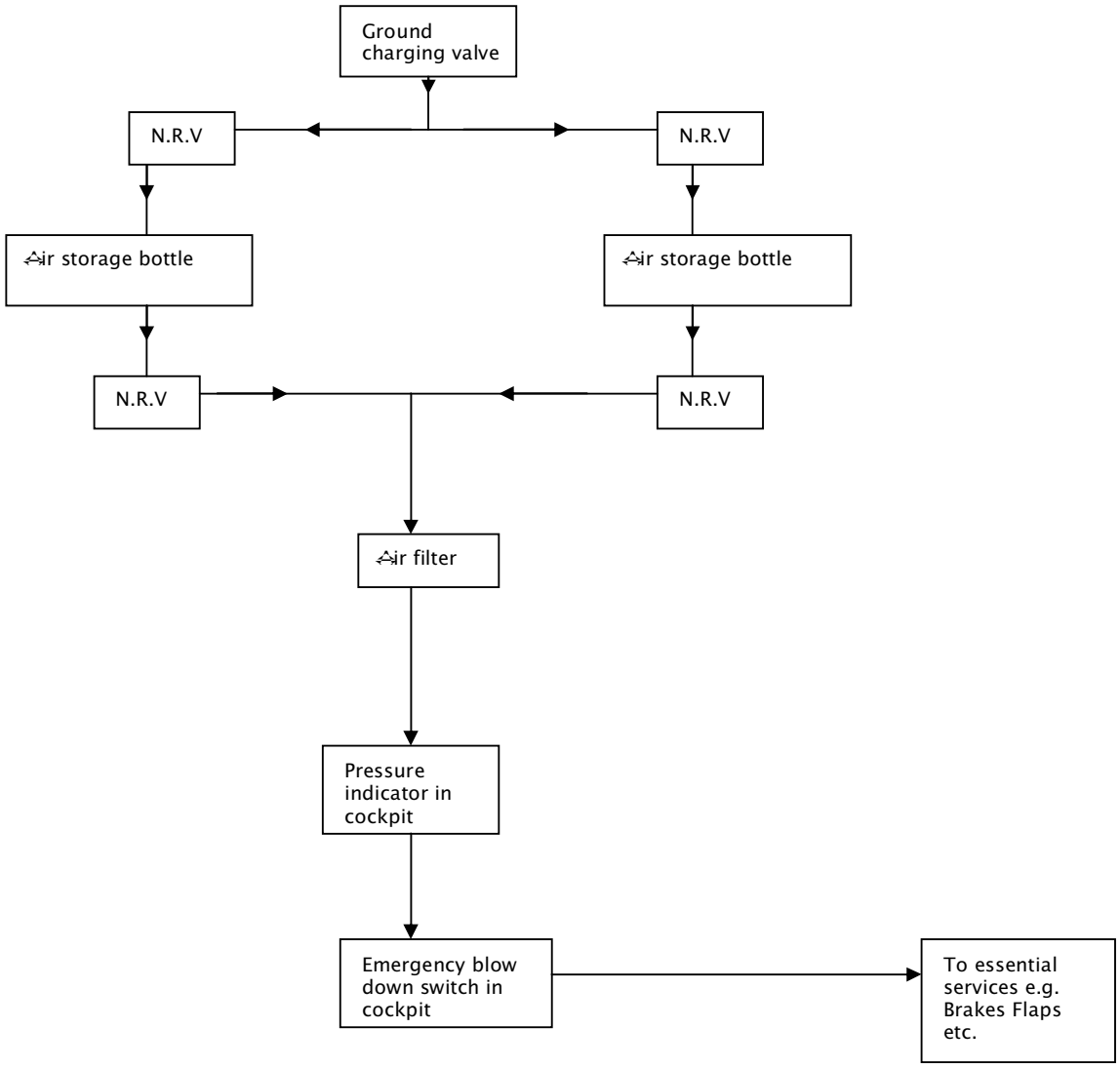
II.IV Never disconnect pressurised airlines.


Reservoir
Hand pump
Filter
Pressure relief valve
N.R.V
Pressure line to non-essential services e.g. flaps landing gear.
Common return form circuits
Ground test connection
Pressure regulator valve
Pressure
Supply
Pressure lines to essential services e.g. power flying controls, brakes.
Filter
Engine driven pump
N.R.V
Pressure switch


To- stbd. Under carriage, nose wheel- from
Shuttle valve
Sequence valve
From power circuit
Pressure regulator valve
N.R.V
Thermal relief valves
Door jack
Control valve
From emergency air system
Sequence valve
To reservoir
Sequence valve
Undercarriage jack
tmosphere
Fluid jettison valve
One-way restrictor


Shuttle valve
Pressure relief valve
From power circuit
Control valve
To reservoir
Throttling valve
Stbd. Flap jack
From emergency air circuit
Thermal relief valve
Port flap jack
Atmosphere
Fluid jettison valve


To reservoir
Brake assembly
Emergency brake vale
Power brake control valve
Anti skid control valves
De-boosters
Shuttle valve
Brake check valve
Brake accumulator
Oil / air transfer tube
Emergency air cylinder
Power brake control valve
Anti skid control valves
De-boosters
Shuttle valve
Brake assembly


Ground charging valve
N.R.V
N.R.V
Air storage bottle
Air storage bottle
N.R.V
N.R.V
Air filter
Pressure indicator in cockpit
Emergency blow down switch in cockpit
To essential services e.g. Brakes Flaps etc.

Hydraulic fluid used, seals to be used and identification

In the system I have designed I would recommend using synthetic hydraulic fluid. Mainly because of its fire resistant properties but it also has a very good operating temperature range.
This fluid is used mainly on modern aircraft because of these reasons, which is why I have also chosen this type.
Synthetic hydraulic fluid, also known as Phosphate ester based fluid, is identified by its green, purple or amber colouring and must only be used with butyl rubber, ethylene or Teflon seals and flexible hoses.
Although it has many benefits there are also some drawbacks, which include the fact that it is classed as an extreme irritant to the skin and eyes so extreme care must be taken when handling synthetic fluid.
Barrier cream must be applied to hands and arms, and fluid resistant gloves must be worn.
During bleeding and pressure testing operations goggles must be worn due to the risk of fluid splashing in the eyes.

Function of components

- Reservoir stores, supplies and receives hydraulic fluid within the system. It can be pressurised or non-pressurised depending on whether it will be flying above or below 15,000ft.
- Filter micronic filter this filter is used in pressurised systems where a high degree of filtration is required for example in circuits that incorporate powered flying controls.
- Hand pump used to supply fluid to the system without having to run the engines, used mainly for testing the aircraft on the ground.
- Pressure relief valve (in power circuit) releases fluid to the reservoir when the pressure exceeds a preset level.
- Non-return valve (NRV) allows fluid in the system to travel in one direction only.
- Engine driven pump (self-idling) supplies a flow of fluid to the system. The pump, which has a variable volume, supplies fluid only when the pressure goes below a preset level. This operation happens because when the demand form fluid is high the pump expands its volume so that it can pump more fluid, as the demand lessens the volume is reduced until there is no demand, then the pump turns itself off.

- Pressure switch illuminates a light in the cockpit when the pressure goes below a preset level.
- Pressure regulator valve directs pressure to all services unless the pressure goes below a preset level it will then only deliver it to essential services.
- Control valve controls the direction of flow of the fluid.
- Thermal relief valve releases hydraulic fluid as it expands due to thermal changes but only when the temperature exceeds (due to the difference in temperatures on the ground and when the aircraft is flying at high altitude) a pre-set temperature.
- Fluid jettison valve releases excess fluid when the nitrogen "blowback" system is used.
- One-way restrictor stops the landing gear wheels dropping on the doors when down is selected.
- Sequence valve (hydraulic) maintains the pressure to prevent the doors closing while the landing gear is locked down.
- Sequence valve the two work in conjunction to make sure the doors open first and close last.
- Pressure regulator valve (special) prevents wheels drooping on the doors during flight
- Jacks convert hydraulic pressure into liner or rotary motion.
- Shuttle valve uses nitrogen to pressurise the system in an emergency
- Throttling valve slows down the fluid to slow down the operation of the flaps.
- Ground charging valve this valve is used to charge and test the system when parked.
- N.R.V the non-return valves are used to prevent load sharing if one bottle fails.
- Air filter used to clean the air used in the system
- Pressure inicator tells the piolt how much pressure is availble in the system
- Emergency blow down switch used in an emergency to temporaraly pressurise the essential systems to enable safe landing

Basic operation of the landing gear, power and flap systems

Pressurised fluid from the power system enters the landing gear system through the nrv. The fluid travels through the control valve and through the next nrv. From the nrv it travels through the hydraulic sequence valve, then in to either the sequence valve or the under carriage jack, through the next sequence valve and the door jack. After this it travels to the opposite undercarriage system and the nose wheel undercarriage system.

Hydraulic fluid is stored in the reservoir, which is pulled through the filter by the pump. The supply connection also connected to this line is used to top up or re-fill the system. From the pump if the fluid is not needed it is directed back to the reservoir. If the fluid is needed it is pumped through to the nrv the to the pressure switch. From the pressure switch it is pumped to the pressure regulator valve, from here it is directed to either essential services if the pressure is low or to all services if the system is operating normally. If the aircraft is being serviced or pressure is needed whilst the aircraft is “parked” the fluid is drawn from the reservoir through the filter by the hand pump. From the hand pump it is sent to the nrv and then to the pressure regulator valve and then on as described as above.

Pressurised fluid enters the flap system from the power system through the nrv. From the nrv it travels through the control valve and to the starboard and port flapjacks. Fluid in the other end of the jack is forced in to the down line through the throttling valve. The pressure and thermal relief valves are not used closed in normal circumstances.

Bibliography

Handouts
Class notes
Aircraft servicing manual