

3. The Structure of the Fully Integrated Land and Air Resource Model (FILARM)

As stated previously, the two key underlying principles involved in the Integrated Land and Air Resource Model are **‘the conservation of resources’** and **‘the model is an interactive system’**. The ‘conservation of resources’ principle dictates that resources cannot be created from nothing and they cannot disappear, unless destroyed or scrapped. The resources are defined as the personnel and equipment involved. The ‘model is an interactive system’ principle determines that any change in any part of the model has a direct cascade effect on many other model components.

With this in mind, the structure of the Fully Integrated Land and Air Resource Model (FILARM) is shown in the resource allocation flow-diagram shown in diagram FILARM. The Fully Integrated Land and Air Resource Model consists of the following components:

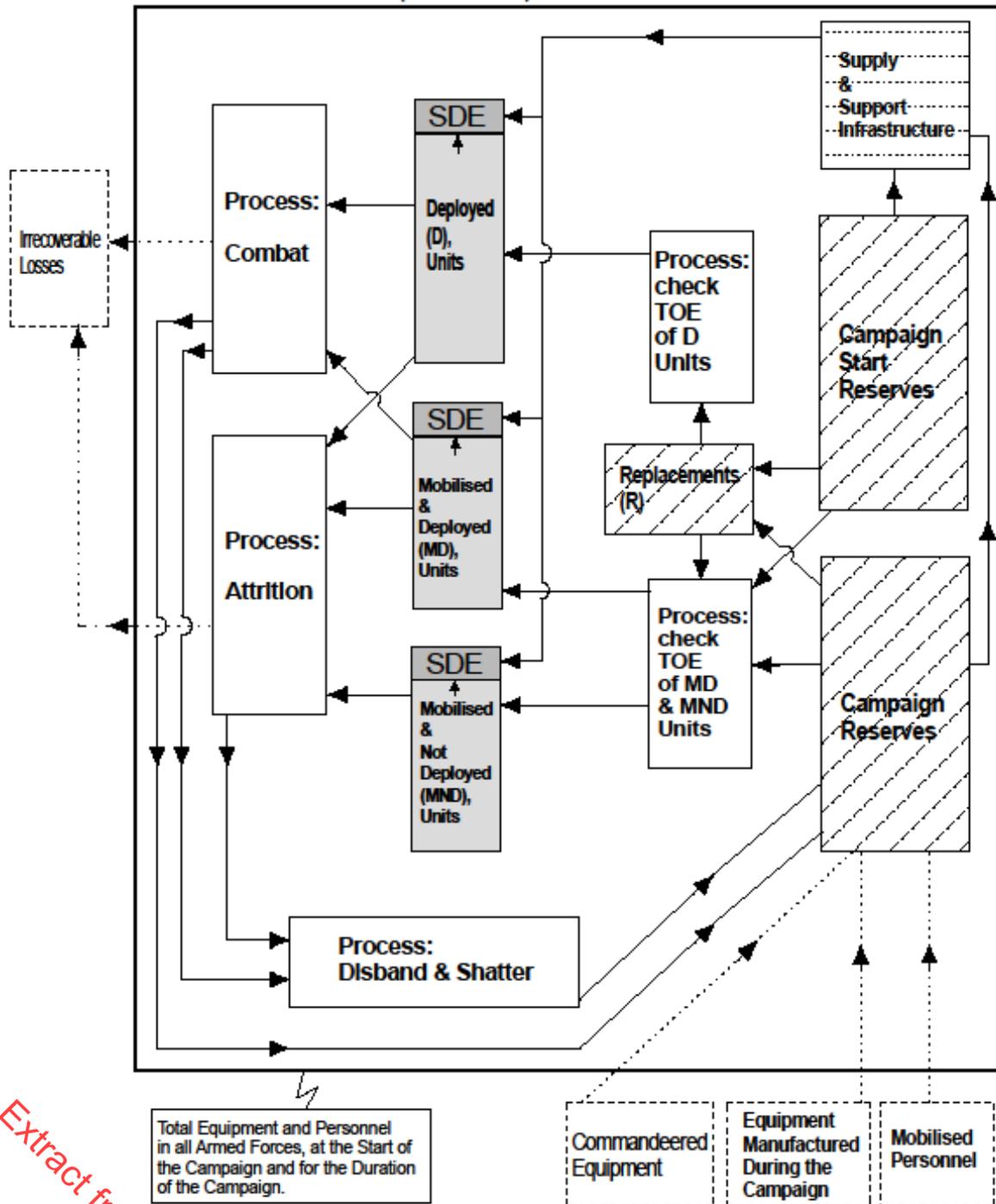
- i. A model representing all resources present in all armed forces at the start of the campaign, and all resources received from all sources during the campaign (symbolised by the enclosed thick-line boundary)
- ii. 3 resource sources and 1 resource destination, outside the model (dashed-line bordered boxes).
- iii. 3 paths by which resources can physically enter the model (dotted lines).
- iv. 2 paths by which resources can physically exit the model (dotted lines).
- v. 21 lines and directions by which resource reallocation can occur within the model (solid lines).
- vi. 7 **‘resource allocation states’** inside the model, made up of:
 - Deployed (D) Combat Units, Mobilised and Deployed (MD) Combat Units, Mobilised and Not Deployed (MND) Combat Units (grey filled boxes).
 - Supply and Support Infrastructure (a dot filled box).
 - Replacements (R), Campaign Start Reserves, and Campaign Reserves (dashed-line filled boxes).
- vii. 5 **‘combat unit processes’** (blank boxes). Combat units must undergo one or more of these processes in order for any resources to be reallocated to combat units within the model, or for any resources to leave the model as irrecoverable losses.

The following is a detail definition of each of the concepts, components, terms and processes used in the FILARM model. Figure FILARM 1 shows the components of the model, the flow of resources into and out of the model, the allocation flow of resources when they are in the model, and the processes that ‘allocated resources’ must undergo to be reallocated.

In some cases, real life examples are given to illustrate the definition or concept used, but complete details are shown in the individual country’s FILARM or PILARM model data (i.e. Volumes II, III and IV).

Extract from Volume I Part I 3.

General Structure of the Fully Integrated Land and Air Resource Model: (FILARM)



Extract from Volume I Part I 3.

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Fig FILARM

1) Resource Sources, Destinations and Paths outside the FILARM Model

The thick-line boundary

The enclosed thick-line boundary in diagram FILARM represents the fully integrated resource model's limits. All resources present at the start of the campaign, and all resources received from all sources during the campaign period, are within the model. The term 'fully' means that all resources, in all physical locations (i.e. all fronts and rear areas) are included.

The thick-line boundary conceptually represents the conservation of physical mass, with the 'mass' being the total resources in that county's armed forces. The only way this can increase or decrease is by resources entering (i.e. new resources) or exiting the model (i.e. irrecoverable losses) along one of the dotted lines (refer below).

The dashed-line bordered boxes

The dashed-line bordered boxes in diagram FILARM represent resource sources and losses. All new resources must come from 'Manufacturing', 'Commandeered Equipment' or 'Mobilised Personnel'. For this purpose equipment received from the Western Allies via Lend Lease is considered to be the same as manufactured equipment.

For the Soviet Union, Germany and Finland all relevant equipment manufactured during the campaign is put into the model. 'Commandeered Equipment' is more difficult and relates primarily to transport. This is very important for the Soviets as they commandeered most of their new transport from the civilian economy during Operation Barbarossa. Although Germany was equally dependent on commandeered vehicles, the large majority were already deployed at the campaign start with limited replacements after that.

For the Soviet Union, 'Mobilised Personnel' of around 9 500 000 is used as the base for the Soviet FILARM model. This is the number of additional personnel that will enter the model (i.e. be available to the Soviet armed forces) from 22nd June to 31st December 1941. This is around 20 times greater than the newly mobilised personnel available to the Wehrmacht during this period. Detail analyses are used to examine these numbers, and the resultant forces, in the respective country's models. It should be pointed out, however, that the 'Mobilised Personnel' represents all trained and untrained personnel. About half of the Soviet manpower mobilised had little or no training, whilst the first 400 000 German replacements were of reasonably high quality. The affect of poorly trained replacements on a force's Relative Overall Combat Proficiency (ROCP) has to be built into the model.

The losses box represents 'Irrecoverable Losses' only. Recoverable losses remain within the integrated land and air resource model (refer to combat and attrition processes below, for definitions of irrecoverable and recoverable losses).

The dotted lines

The dotted lines in diagram FILARM represent resources entering and exiting the model.

Resources cannot be created, unless they enter the model from 'Manufacturing', 'Commandeered Equipment' or 'Mobilised Personnel'.

Resources cannot disappear (cease to exist), unless they exit the model via the 'Combat Process' or 'Attrition Process', as 'Irrecoverable Losses'.

Extract from Volume I Part I 3.

2) Resource Reallocation Paths within the FILARM Model

In diagram FILARM, the solid lines represent the resource reallocation paths (or resource allocation flow) within the FILARM model. The properties of the resource reallocation paths in the FILARM model are as follows:

- i. In order for any resources to be reallocated from one 'Resource Allocation State' to another, they have to proceed along one or more of these reallocation paths. **This is termed a 'reallocation event'**.
- ii. All resource reallocation paths are mono-directional.
- iii. There are only 21 possible paths and directions along which resources reallocation can occur within the model.
- iv. Resource reallocation can occur along alternative paths within the model, and the number of paths (lines) used during a particular reallocation event is unlimited.
- v. A resource may have to go through several 'Resource Allocation States' and 'Combat Unit Processes' (described in succeeding sections) during a single reallocation event. Resource reallocation is not limited by the number of 'Resource Allocation States' and 'Combat Unit Processes' it may go through during a single reallocation event.

Immediately prior to the campaign start, all resources are allocated to one of the following 'Resource Allocation States': 'Deployed (D) units', 'Supply and Support Infrastructure', 'Replacements (R)' or 'Campaign Start Reserves'. After the campaign start, and once a resource has entered the FILARM model, it may be reallocated to any 'Resource Allocation State' except 'Campaign Start Reserves'. Note there is no resource allocation path entering 'Campaign Start Reserves'. Thus the resources in 'Campaign Start Reserves' only reduce during the period of the campaign, although many of these resources will be recycled via the 'Campaign Reserves State'.

It is important to understand that **resource reallocation does not necessarily mean any physical movement of the personnel or equipment concerned**, although in reality it would probably involve some physical relocation. A particular resource may, and usually does, undergo both reallocation and physical relocation simultaneously.

For example, 30 new T-34 tanks left training units in Moscow in June 1941 and were reallocated to the 1st Mechanised Division, moving at that time from Moscow to the Western Front. In the FILARM model, the reallocation event involved tanks being reallocated from Stavka reserves (part of the 'Campaign Start Reserves') to the 1st Mechanised Division (a Deployed (D) combat unit). The reallocation paths used were: from 'Campaign Start Reserves' to 'Replacements (R)', and then onto a 'Deployed (D)' unit via the relevant 'Check TOE Process'. Simultaneously the tanks physically moved from Moscow to the Smolensk area.

Resources are often reallocated without significant physical relocation.

For example, on 21st September 1941 the 1st Mechanised Division was formed into the 1st Guards Motorised Division. The unallocated resources resulting from 'Disbanding' of the 1st Mechanised Division (a Deployed (D) combat unit) were reallocated to the 'new' 1st Guards Motorised Division (a Mobilised and Deployed (MD) combat unit), without physically moving any significant distance. In this case the complete sequence of processes and resource reallocation is represented in diagram FILARM as follows: Resources were reallocated from units in a D state, via the 'Attrition Process' and the 'Disband and Shatter Process', to the 'Campaign Reserves State'. Then the resources were reallocated, via the 'Check the TOE Authorisation of a MD or MND Unit Process', to a MD combat unit. This is one of many examples in the Red Army during Operation Barbarossa, where a combat unit was disbanded with the specific plan of reallocating all its resources, and part of its initial TOE structure, to form a 'new' unit. The properties of the resource reallocation paths in the FILARM model (detailed above), is a very important part of the Soviet FILARM model's 'Disband and Shatter Process'.

¹ Refer to Volume I, Part I, 3.4) e. ii. – 'The Structure of the Fully Integrated Land and Air Resource Model (FILARM) - Combat Unit Processes inside the FILARM Model - Disband and Shatter process - Combat Unit Disbandment' for details. This procedure is almost entirely (and extensively) utilised by the Soviet FILARM model, where it is discussed in detail. This is because the massive Soviet mobilisation programme in 1941, called for a large number of existing divisions to be renamed and reformed as 'new' divisions. Also refer to Volume III - 'The Soviet Armed Forces, Mobilisation and War Economy from June to December 1941', chapter title 'Soviet Mobilisation After 22nd June 1941: The Actual Strength of all Soviet Land Combat Units Mobilised from 22nd June to 31st December 1941'.

The reader should note that, **the direction of the arrows on the reallocation paths (lines in diagram FILARM) strictly represents resource allocation flow direction.**

For example, resources in all combat units can only return to the ‘campaign reserves’ as recoverable losses due to combat or attrition, or if the combat unit to which it is allocated is disbanded or shattered. To enable the reader to further grasp how resource reallocation works in the FILARM model, consider the following historical example.

A new T-34 tank was manufactured in Stalingrad in June 1941. The 8th Tank Division (Deployed (D) on 22nd June 1941 in the Kiev Special Military District) was fighting against Army Group South, and had fewer than half its initial complement of 140 T-34s left by July 1941. The new T-34 was reallocated to the 8th Tank Division as a replacement in August 1941 (at Dnepropetrovsk, where the division was stationed in reserve). In mid-September 1941 the 8th Tank Division was disbanded, and its two tank regiments were used to form the 130th and 131st Tank Brigades, both with TOEs authorising T-34s. The original (new) T-34 survived long enough to be transferred to the 130th Tank Brigade in September, but was lost in combat near Rostov in late 1941.

In the FILARM model, the above example involves two distinct reallocation events. In the first event, the T-34 resource enters the model from ‘Equipment Manufactured During the Campaign’, and goes into ‘Campaign Reserves’. Stavka reallocates the tank as a Replacement (R). After checking that 8th Tank Division’s TOE authorises T-34 tanks (the ‘Check the TOE Authorisation of a Deployed (D) Unit Process’), the T-34 is reallocated to the 8th Tank Division from Replacements (R). Therefore the resource was reallocated from ‘Campaign Reserves’ to a ‘Deployed (D) combat unit’, and will physically move from Stalingrad to South West Front.

The second reallocation event occurs when (or if in the simulation) the 8th Tank Division is disbanded. In this case the T-34 is reallocated via the ‘Attrition Process’, the ‘Disband and Shatter Process’, the ‘Campaign Reserves’, the ‘Check the TOE Authorisation of a MD Unit Process’ (to check September 1941 tank brigades are authorised T-34s), and to the new 130th Tank Brigade. Therefore the resource was reallocated from a ‘D combat unit’ to a ‘MD combat unit’, without any significant physical relocation.

Lastly, in late 1941, the T-34 goes through the ‘Combat Process’ and exits the integrated land-air model as an ‘Irrecoverable Loss’.

Extract from Volume I Part I 3.

3) Resource Allocation States inside the FILARM Model

As stated previously, there are seven possible 'Resource Allocation States' inside the FILARM model, made up of: 'Deployed (D) units', 'Mobilised and Deployed (MD) units', 'Mobilised and Not Deployed (MND) units', 'Supply and Support Infrastructure', 'Replacements (R)', 'Campaign Start Reserves' and 'Campaign Reserves'. The D, MD and MND states are 'combat capable' states and units in these states are therefore referred to as 'combat units'.

a. Combat Units: D, MD and MND

The three grey filled boxes in diagram FILARM represent combat units in the armed forces to which resources are allocated. In the FILARM models simulating Operation Barbarossa, the armed forces include army, air force (including naval air), militia, rear area support, and naval personnel seconded to the army. All combat capable organisations (or combat units) in the armed forces have a TOE regardless of size. They are specifically categorised into one of the following:

i. Deployed (D)

The combat unit is deployed with a TOE anywhere in the armed forces on the first day of the campaign, in this case 22nd June 1941. The unit may be deployed at a fraction of its full TOE strength and it may be allocated to any military district or army.

The details and assignments of all units in a Deployed (D) status are detailed in the **Deployment Matrices** for each country. There is a separate Deployment Matrix for each of the land, air and naval forces deployed in Operation Barbarossa.²

ii. Mobilised and Deployed (MD)

The combat unit is mobilised with a TOE after the first day of the campaign, in this case 22nd June 1941, and allocated (or assigned) to an 'Active Front or Army HQ'.

For the Soviets an 'Active Front or Army HQ' is any front or army HQ in the west USSR. In this case 'west' is defined as west of a line running north-south 100km west of the Urals. This therefore includes all front or army HQs in the USSR except those in the Urals, Siberia, Central Asia and Transbaikalian Military Districts, and the Far Eastern Front.³

For Germany and Finland, an 'Active Army HQ' is any operational army HQ in the armed forces. Note, Germany had multiple theatres of war (or active fronts) in 1941, all with active army HQs. Even occupying forces (such as those in France, Norway and the Balkans) were still in active war fronts. These units were organised and operated on a war footing, and in most cases were carrying out military and security operations. Hence newly mobilised Wehrmacht units which were allocated to HQs in these theatres are considered to have been Mobilised and Deployed (MD).⁴

iii. Mobilised and Not Deployed (MND)

The combat unit is mobilised with a TOE after the 1st day of the campaign, in this case 22nd June 1941, and **NOT allocated (or assigned) to any 'Active Front or Army HQ'**. An 'Active Front or Army HQ' is as defined as for the MD state above.

In addition, a unit which is created by a simple name change from an old unit without the addition of any new subunits from reserves is considered a Mobilised and Not Deployed (MND) unit. This is because the unit in question is already deployed on the battlefield and simply changes its name. In so doing the old unit ceases to exist. In effect the new unit becomes deployed, but the old unit it is replacing simultaneously becomes 'un-

² For example, Volumes IIB and IIIA, chapters titled 'The Order of Battle (OOB) of German Land Combat Units from 22nd June to 4th July 1941' and 'The Order of Battle (OOB) of Soviet Land Combat Units on 22nd June 1941', respectively, contain the Deployment Matrices of German and Soviet ground forces. Similar, but separate, Deployment Matrices are present for the respective air-forces.

³ Refer to Volume IIIB, chapters titled 'Soviet Mobilisation After 22nd June 1941: The Actual Strength of all Soviet Land Combat Units Mobilised from 22nd June to 31st December 1941' and 'The Soviet Air Forces in 1941 - Soviet Air Combat Unit Reinforcements: June 1941 to January 1942', for details on Soviet land and air combat units Mobilised and Deployed (MD) in 1941.

⁴ Refer to Volume IIB, chapters titled 'German Mobilisation After 22nd June 1941: the Actual Strength of German Land Combat Units Mobilised from 22nd June to 31st December 1941' and 'The Luftwaffe in 1941 - Luftwaffe Air Combat Unit Reinforcements: June to December 1941', for details on German land and air combat units Mobilised and Deployed (MD) in 1941.

deployed'. If no personnel or equipment are added from reserves, **then the net effect is that the deployment of new reserves is zero.**⁵

The MND state is of particular importance in the Soviet FILARM model because of their massive mobilisation program. Detail examination of each Soviet combat unit mobilised in 1941 shows that many were:

- Old units (usually divisions) with simple name changes, and were not 'new combat units' at all. Many of these divisions received no additional personnel and equipment from reserves (apart from Replacements (R) which is dealt with in a separate process). In this case the unit is classified as a MND unit.
- Old units (usually divisions) with simple name changes, and which were only partially new units. In these cases some personnel and equipment was added from reserves, usually in the form of a newly mobilised battalion or regiment. This was most common if the division type was also changed, which was common in the Red Army in 1941 (e.g., many existing mechanised divisions were changed into 'new' rifle divisions by simply changing their name and adding an additional new rifle regiment). In this case, only the newly mobilised portion of the so called 'new' combat unit is classified as MD, while the portion of the unit that 'came into existence' purely due to a name change is classified as MND.⁶
- Effectively paper organisations with only a commander and a few men (a cadre), and which were never assigned to an 'Active Front or Army' in 1941. In this case the unit is classified as a MND unit.
- Brand new units which had only started mobilising very late in 1941 and which were still barely formed before the end of the year. These units were not combat ready in any sense and not assigned to any 'Active Front or Army' in 1941. In this case the unit is classified as a MND unit.⁷

Discussion and detail of all MND units is carried out in each county's relevant FILARM and PILARM models.

b. Supply and Support Infrastructure

The a dot filled box represents supply and support infrastructure outside the TOE of individual combat units, but within the structure of the armed forces, to which resources may be allocated. 'Supply and Support Infrastructure' includes only non-combat capable units which may or may not have had a TOE. They include the following:

- All rear area corps, army, front and army group, supply and support organisations.
- Supply organisations working between railheads or ports, and corps or army supply depots. The latter is normally where combat unit (usually divisional) supply services pick up supplies.
- Rear area maintenance, repair, signal, intelligence and security organisations which are not normally capable of involvement in frontline combat (i.e. are non-combat units). Historically, some of these unit types were in actuality combat capable units. Examples were the German security divisions, NKVD rail security divisions, and some bridging engineer units. Note, all these unit types are already included as combat units with a TOE in a D, MD or MND state described above (even though many of these units were barely capable of direct combat and were really only designed for rear area support operations).
- Rear area air-force support, aircraft and airfield supply and maintenance, and air-force security and signal units, all of which are not normally capable of involvement in frontline combat.

⁵ Ibid (previous two notes), for details on all Soviet and German land and air combat units Mobilised and Not Deployed (MND) in 1941. Also, it should be carefully noted here that all D, MD and MND combat units may still receive newly mobilised personnel and equipment (i.e. reserve forces) via the Replacement (R) process. In the FILARM model the **Replacement (R) process is a separate process to creating completely new combat units.** In this way combat units which are considered newly mobilised but were in fact merely old units with a simple name change, can still build up their strength to their TOE, given enough time and priority treatment.

⁶ For example the 131st Rifle Division started forming on the 3rd July 1941. It was quickly formed by redesignating the existing pre-war 131st Mechanised Division as a rifle division, and adding the new 743rd Rifle Regiment from reserves. This was the only truly new component of the so called "new 131st Rifle Division". In this case the 131st Rifle Division is still a MD unit, but it arrives (i.e. is Deployed (D) on the battlefield) with only the 743rd Rifle Regiment: the remainder of the division in the Barbarossa simulation comes from the remnants of the pre-war 131st Mechanised Division, as occurred historically. In effect, 1/3 of the 131st Rifle Division is classified as MD, while 2/3s is classified as MND.

⁷ An example is the 427th Rifle Division. This unit started mobilising in December 1941 whilst in the Moscow region. The 427th was still mobilising (forming) on 2nd January 1942 when it was redesignated the 149th Rifle Division. It was not assigned to an active army (the 61st Army) till February 1942. Considering the state of many new units assigned to 'Active Fronts or Armies' and committed to combat by the Red Army in 1941, this type of MND unit must really have been in an early state of formation and training. However these units still consumed resources, although relatively few, in 1941.

The key parameters used to measure supply and support infrastructure in each FILARM model are the numbers of dedicated rear area personnel, as well as the overall lift capacity available in rear-area trucks, light transports, prime movers and horse drawn transport. From diagram FILARM we can see that 'Supply and Support Infrastructure' is critical in increasing a combatant's overall Supply Distribution Efficiency (SDE).

The other critical source of 'Supply and Support Infrastructure' is the support infrastructure within the combat units themselves (which are included in the TOEs of those combat units). This is indicated graphically in diagram FILARM by the dark-grey SDE box above each of the D, MD and MND 'Resource Allocation States'.

Therefore, the overall Supply Distribution Efficiency (SDE) of D, MD and MND combat units is a function of the rear area 'Supply and Support Infrastructure' and the TOE infrastructure within the combat units themselves.⁸

c. Reserves and Replacements (R)

The three dashed-line filled boxes in diagram FILARM represent reserves in the armed forces to which resources are allocated. Reserves in the armed forces may or may not have a TOE, and are not directly combat capable. They are categorised into one of the following:

i. Replacements (R)

'Replacements (R)' are personnel and equipment allocated to rebuild combat units which are in a D, MD or MND state, to the level of their currently authorised TOE. A unit may be below TOE strength due to loss of resources from combat, training and rear area attrition, or scrapping. Alternatively, it may be below TOE strength in its initial peacetime deployment and require newly mobilised resources to bring it up to full strength in time of war.

The latter condition is particularly important in the Soviet FILARM model because none of the rifle divisions in the Western Military Districts (or anywhere else in the Red Army), were at their authorised TOE strengths on 22nd June 1941. The divisions in the Far East came closest. Most rifle divisions were at the '6' or '12' level, indicating either 6 000 or 12 000 men on strength.⁹ Despite having mobilised 500 000 men in the spring of 1941, to bring the rifle divisions in the Western Military Districts up to the '12' strength, most of these divisions contained considerably fewer than 12 000 men in June 1941.¹⁰ Even a '12' strength division was well below the TOE, which authorised 14 483 men in a rifle division at this time.¹¹ In addition, most rifle divisions in the Western Military Districts were missing 33% to 66% of their horses and, much worse, 25% to 80% of their motor vehicles. They did however have most of their heavy weapons. The result was personnel weak, transport weak, and equipment strong divisions, which needed infantry and transport replacements as soon as possible.

The Soviet mobilisation plan called for these divisions to receive sufficient men and equipment to bring them up to full strength within 7-14 days of hostilities commencing. With regards to transport, this simply never happened: transport which was supposed to arrive from the civilian economy mostly never appeared, was diverted to newly mobilising units, or was overrun by the enemy before it could be commandeered and issued. However, in the case of personnel the Soviets did manage to mobilise 3 000 000 reservists in June and July 1941. These were immediately dispatched to the front to bring the divisions in the Western Military Districts up to strength.¹²

The Soviet FILARM model must therefore include this massive influx of manpower in June 1941, to bring any surviving Red Army divisions close to their authorised personnel at least. It is worth noting that the beauty of the integrated resource model is that if the Soviets (in a Barbarossa simulation) lose even more divisions in June and July 1941 than was historically the case, then this influx of replacements will be diverted into newly mobilising divisions, making them stronger more rapidly.

j. Campaign Start Reserves

'Campaign Start Reserves', or existing reserves at the campaign's start, are resources not allocated to any combat unit in a Deployed (D) state at the start of the campaign. 'Campaign Start Reserves' include equipment

⁸ Refer to Volume I, Part I 8. - 'Supply Distribution Efficiency (SDE)' for details on how SDE is calculated.

⁹ C. C. Sharp, 'Red Legions': Soviet Rifle Divisions Formed Before June 1941, Soviet Order of Battle WWII: Volume VIII, George F. Nafziger, West Chester, OH, 1996, p.5.

¹⁰ D. M. Glantz, *Stumbling Colossus*, University Press of Kansas, Lawrence, Kansas, 1998, pp. 110-116.

¹¹ C. C. Sharp, 'Red Legions': Soviet Rifle Divisions Formed Before June 1941, Soviet Order of Battle WWII: Volume VIII, George F. Nafziger, West Chester, OH, 1996, p.105, Also D. M. Glantz, *Stumbling Colossus*, University Press of Kansas, Lawrence, Kansas, 1998, p. 111 and Table 5.2, p. 152.

¹² D. M. Glantz, *Stumbling Colossus*, University Press of Kansas, Lawrence, Kansas, 1998, note 11, p.298.

and personnel in training and rear areas which may be in an active Military District, but which are not allocated to any combat unit. 'Campaign Start Reserves' may subsequently be committed to: any MD or MND combat unit, Replacements (R), or area support units (to improve SDE) during the course of the campaign.

'Campaign Start Reserves' include old or obsolete equipment, which may have been stockpiled for many years. It should be noted from diagram FILARM that the 'Campaign Start Reserves' box has no resources allocation entering the box. This means that the 'Campaign Start Reserves' are fixed at the campaign start, are subsequently used up during the campaign (e.g. Soviet), or are largely left unused for the duration of the campaign (e.g. German). Any resource exiting the 'Campaign Start Reserves' (being assigned to another 'Resource Allocation State') may still end up in 'Campaign Reserves' if it is not irrecoverably lost. In this way an unassigned and obsolete resource (e.g. an old tank that started the war in storage) may still find itself assigned to various combat units over the course of its life. The Finnish Army's artillery park is probably the best example of this: they went into WWII with a lot of artillery dating from the 19th century; before hydro-pneumatic recoil systems were even invented!

'Campaign Start Reserves' were particularly important to the Soviets in 1941. The Soviet FILARM model shows that the Soviet's huge initial 'Campaign Start Reserves' were almost entirely used up to supply its massive mobilisation effort. Almost regardless of how old or in need of repair equipment was, practically all Soviet equipment went directly into MD or MND combat units, was allocated as Replacements (R), or went into supply and support infrastructure. Most of the really old and least serviceable Soviet weapons, particularly tanks and aircraft, went into MND combat units. Many of these newly mobilised units remained in the Far Eastern Front, and the Transbaikal, Central Asia, Siberia and Urals Military Districts from June to December 1941.

Conversely, a substantial portion of the equipment in the German 'Campaign Start Reserves' remained in reserves in Germany during the 1941 campaign. This equipment was not allocated to units which went into a MD or MND state during the campaign, including those in the Wehrmacht's Replacement Army. In addition, this equipment was not allocated as direct Replacements (R) for combat unit on the East Front or in North Africa.

The respective country's land and air resource models show the historical use of their 'Campaign Start Reserves' in detail.

iii. Campaign Reserves

'Campaign Reserves' are resources received during the campaign. Resources are received from 'Manufacturing', 'Commandeered Civilian Equipment' or 'Newly Mobilised Personnel'. In addition resources are received as recoverable losses after the campaign start via the 'Combat Process' and the 'Disband and Shatter Process' (refer processes below). 'Campaign Reserves' may be committed to any newly mobilising unit which then goes into a MD or MND state during the campaign, and they may be committed as Replacements (R) during the campaign.

Like the Soviet 'Campaign Start Reserves', the Soviet 'Campaign Reserves' were almost entirely used up to supply its massive mobilisation effort. In June 1941 the Soviet war economy was not geared up to the production levels it would achieve later in the war, and it was handicapped in the second half of 1941 by having to move large numbers of critical factories eastwards to the Urals. This took many factories offline for part of 1941-42. However Soviet production was still very large and proved critical to forming and supplying new units. The Soviet FILARM model clearly demonstrates that virtually all the Soviet 'Campaign Reserves' went into new units MD or MND combat units, were allocated as 'Replacements (R)' for all combat units, or went into 'Supply and Support Infrastructure' from June to December 1941.

In many traditional accounts of WWII, Germany comes under criticism for its low war production output from 1939 to 1942. However Germany's war production was significant even in 1941, and the German FILARM model shows that a substantial portion of the equipment in the German 'Campaign Reserves' remained in reserves in Germany during the Barbarossa campaign. This equipment was not allocated to combat units which went into a MD or MND state during the campaign, including those in the Replacement Army. In addition this equipment was not allocated as direct 'Replacements (R)' to combat units on the East Front or in North Africa.

A good example is the Sturmgeschutz (StuG) III Assault Gun (Sd Kfz 142). If there was a weapon which should have been rushed to the East Front in 1941, it was this one. Between 22nd June and 4th July 1941, 301 StuG III Assault Guns were sent to the East Front. From July 1941 to January 1942 (inclusive) an additional 132 StuG IIIs arrived on the East Front with six new StuG battalions and the 227th Infantry Division, and an

additional 7 remained in the German Replacement Army (in the west) in another newly forming battalion.¹³ There were 377 assault guns available to the Wehrmacht on 1st June 1941 and a further 348 were received by the end of 1941, of which 40 were received from manufacturing in December 1941. Yet despite this, only 15 StuG III Replacements (R) were sent to combat units on the East Front in 1941.¹⁴ This means that a paltry 5% of the available assault guns were sent as Replacements (R) to the East Front in the second half of 1941 (15 out of a possible 285 unallocated). Even if we exclude the 40 StuG IIIs manufactured in December 1941, and maintain around 30 in the Replacement Army for training purposes, then around 200 additional StuG IIIs were still available to the Wehrmacht for use as Replacements (R) on the East front From July to December 1941.

All this was despite all the StuG battalions in the East being almost continuously in action and crying out for replacements from October 1941 onwards. This is especially striking considering that the Soviets were “scrapping the bottom of the barrel” with old and obsolete tanks to produce large numbers of tank brigades. One can only assume the new assault guns were earmarked for new battalions which were planned to be mobilised in the west in 1942. I’m sure the highly trained German StuG crews, who had lost their vehicles and were being wasted by fighting as infantry in the winter of 1941-42, would have appreciated the assault gun replacements sitting in reserve in Germany! The German FILARM model serves to highlight similar examples of what can be described as incompetent strategic planning and strategic overconfidence by the German High Command.

¹³ The 209th Assault Gun Battalion arrived after 31st December 1941. The 249th Assault Gun Battalion remained in the West.

¹⁴ H. Boog, et al. (German Research Institute for Military History at Potsdam), Germany and the Second World War, Volume IV: The Attack on the Soviet Union. Oxford University Press, New York, 1996, p. 219, table I.iii.4, and pp. 1120 and 1122. Also, P. Chamberlain, H. Doyle, T.L. Jentz, Encyclopedia of German Tanks of WWII, Arms and Armour Press, London, 1994, appendices VII, p. 261. Also, refer to Volume II (the German FILARM model) for further details.

4) Combat Unit Processes inside the FILARM Model

In diagram FILARM, the five blank boxes (with no filling) represent ‘Combat Unit Processes’. **Combat units must undergo one or more of these processes for any resources to be reallocated within the model, or for any resources to leave the model** (as irrecoverable losses).

The ‘Combat Unit Processes’ in this context can be viewed as the effect of ongoing tactical and operational decisions, made by the various military commands, on an armed force’s structure and allocation of resources. There are five processes involved and they are categorised under the following headings.

a. Checking the TOE Authorisation of a Deployed (D) Combat Unit

The subject of TOEs (Tables of Organisation and Equipment) is discussed at length later in this work, and examined in detail in each of the combatant’s respective resource models.¹⁵

All combat units and most non-combat units had a TOE, which set the framework for the organisational structure and authorised equipment for that particular unit. Even though most combat units were actually below their TOE strength, the TOE was still very important because it was created by the general staff of the military high command in order to meet the perceived demands that they believed were likely to be placed on their forces. As such, the various TOEs reflected the state of the tactical, operational and even strategic thinking in the armed force at that time. In addition, it made sense for the military high command to select a TOE which had a reasonable chance of being fulfilled with that country’s available resources. In the FILARM models, the TOE is the structure that combat units will attempt to emulate during formation or by using Replacements (R).

For any Operation Barbarossa simulation, the ‘Checking the TOE Authorisation of a Deployed (D) Unit’ process will therefore check whether a particular land or air unit is authorised to receive the resource based on currently active **TOEs issued before 22nd June 1941**. If the unit is authorised by its current TOE to receive the resource then, depending on priorities, it may be allocated the resource.

It should be noted that TOEs were general orders issued to all units of a certain type. However there were often variations (from the standard) within the TOE of a particular combat unit, either relating to equipment or organisational structure. These differences in TOE were usually due to equipment availability. Sometimes more ‘elite’ or ‘one off’ units might have additional equipment and small organisational differences. In these cases individual combat unit TOEs are used in the FILARM model, reflecting the actual equipment the unit was likely to receive.

For example, the German 7th Infantry Division followed the overall TOE structure of a standard German first wave infantry division, except that it had two bicycle squadrons and no armoured cars in its reconnaissance battalion, and a slightly different supply infrastructure. This variation is therefore included in the specific TOE for the 7th Infantry Division, in the German FILARM model. Another example is Soviet tank divisions. The Soviet July 1940 tank division *Shtat* (TOE) authorised T-34 tanks. However most Soviet tank divisions in 1941 never received any T-34s, and they were mostly equipped with older T-26s and BT tanks in June 1941. In all these cases the tank types that were historically present are ‘authorised’ in the particular division’s TOE. This is because it would be very unrealistic for a tank division with 200 BT-7s to receive a single T-34 as a replacement.

Finally it should be mentioned that a large proportion of military simulations make the serious mistake of using a combat unit’s TOE as indicative of its actual strength before it went into battle. This usually occurs due to the absence of any other recorded information, or because they don’t have an integrated resource model! Probably the best example in Operation Barbarossa of the frequently large difference between TOEs and actual strength is the Soviet 1941 mechanised corps. The Soviets had decided to abandon the tank corps structure in November 1939, following experience in Spain. However the Soviets realised they were originally on the right track when they saw the German results in France in 1940, and so they belatedly started reforming the massive mechanised corps (each with two tank divisions and one mechanised division). The order to form the first batch of eight mechanised corps and their component tank divisions came in June 1940, and another mechanised corps was ordered formed in November 1940. This meant nine mechanised corps and 20 tank divisions (including two separate tank divisions) were formed in barely six months. On top of this the Soviets made the rather amazing decision to form no fewer than 20 additional mechanised corps in February 1941. Consequently, on 22nd June 1941 most of the 29 existing mechanised corps were nowhere near fully equipped or combat ready, even though they all had very impressive TOEs!¹⁶

¹⁵ Refer to Volume I, Part I 6. – ‘Tables of Organisation and Equipment (TOE)’.

¹⁶ Refer to Volume IIIA, chapter and section titled ‘The Actual Strength of all Soviet Land Combat Units in a Deployed (D) State on 22nd June 1941 - Review of the Overall Strengths of Selected Red Army Units and PVO forces on 22nd June 1941’.

b. Check the TOE Authorisation of a MD or MND Combat Unit

This process is identical to the previous one, except it relates to **TOEs issued after 22nd June 1941** for newly mobilised units.

This process applies almost entirely to the Red Army and Red Air Force (VVS) in the Operation Barbarossa simulation, and is used extensively in the Soviet FILARM model. After the disastrous border battles in June and early July 1941, the Soviet high command quickly realised that they did not have the resources to fill the TOEs of the large pre-war divisions, and that they did not have the command, control or support systems to handle such large and unwieldy formations as the pre-war mechanised corps. To address this situation the Soviet high command quickly issued new TOEs which dramatically reduced the size and complexity of many existing division types. In addition, TOEs were issued for a whole range of new and smaller combat unit types, of which the 1941 rifle and tank brigades are the most well known. These TOE changes are all detailed in the Soviet FILARM model (Volumes IIIA and IIIB).

Good examples of the rapidly changing TOEs in the Red Army from July to December 1941, are those issued for the tank and mechanised formations. A new reduced tank division TOE was issued on 10th July 1941, only 19 days after Operation Barbarossa commenced. On 15th July 1941 the mechanised corps HQs were disbanded and many mechanised divisions became rifle divisions (in terms of actual equipment, many of the pre-war mechanised divisions were almost rifle divisions anyway).¹⁷ On 23rd August 1941 the Red Army temporarily abandoned the entire tank division concept, and new TOEs were issued for much smaller and easier to control tank brigades. Progressively smaller tank brigade TOEs were authorised on 13th September 1941 and again on 9th December 1941.¹⁸

Red Army rifle units changed in a similar fashion: new rifle division TOEs were issued on 29th July 1941, reducing personnel from 14 483 to 10 790 and reducing the heavy weapons by almost 50%. Another new rifle division TOE was issued on 6th December 1941.¹⁹ In addition new separate rifle brigades were formed according to a new TOE dated 15th October 1941. These units were authorised only 4 356 men with only 24 45mm-76mm guns, and had virtually no support infrastructure.²⁰

The Soviet FILARM model includes all new TOEs for all newly mobilised combat units, and all new TOE revisions within a particular unit type. Any new units which have a 'formation start date' on or after the 'TOE issue date' will be created with the latest TOE structure in the Operation Barbarossa simulation.²¹

A similar situation to the one above befell the Soviet Air Force (VVS) in 1941. The Soviets issued new reduced strength TOEs for their aviation regiments in August 1941.²² The air-model component of the Soviet FILARM model includes all the new TOEs for new aviation regiments (and other air units types) created after 22nd June 1941.

c. The Combat Process

This is essentially the process of battle. The day to day tactical and operational decisions made by the military command are represented by the 'Combat Process', and to a lesser extent by the 'Attrition Process' and 'Disband Process' (described below). As such, the 'Combat Process' has the greatest impact on an armed force's overall force structure, and the subsequent allocation of resources. This is where the Barbarossa simulation 'commanders' may choose to spend most of their time and effort: possibly attempting to emulate or surpass the historical performance of famous Soviet or Axis commanders.

- The Mechanised Corps', for a summary of the Red Army's mechanised corps actual strengths in June 1941 compared to their TOEs. Many mechanised corps were mere skeletons of much larger organisations, and were still barely formed.

¹⁷ Many mechanised divisions were redesignated as rifle divisions by adding a rifle regiment from reserves. This created the three rifle regiments normally attributed to a rifle division. In most 'converted' mechanised divisions, the division's tank regiment and most of the motorisation either never existed or had been wiped out by July 1941.

¹⁸ S. J. Zaloga, L. S. Ness, *Red Army Handbook 1939-1945*, Sutton Publishing, Stroud, UK, 1998, pp. 70-74. Also, C. C. Sharp, 'The Deadly Beginning': Soviet Tank, Mechanised, Motorised Divisions and Tank Brigades of 1940-1942, *Soviet Order of Battle WWII: Volume I*, George F. Nafziger, West Chester, OH, 1995, pp. 15, 51, 93.

¹⁹ S. J. Zaloga, L. S. Ness, *Red Army Handbook 1939-1945*, Sutton Publishing, Stroud, UK, 1998, pp. 13-15. Also, C. C. Sharp, 'Red Tide': Soviet Rifle Divisions Formed From June to December 1941, *Soviet Order of Battle World War II: Volume IX*, George F. Nafziger, West Chester, OH, 1996, pp. 118-121.

²⁰ S. J. Zaloga, L. S. Ness, *Red Army Handbook 1939-1945*, Sutton Publishing, Stroud, UK, 1998, p. 37. Also, C. C. Sharp, 'Red Volunteers': Soviet Militia Units, Rifle and Ski Brigades 1941-1945, *Soviet Order of Battle WWII: Volume XI*, George F. Nafziger, West Chester, OH, 1996, pp. 96-97.

²¹ It should be noted that when a combat unit is created with a particular TOE, it does not change its structure for the duration of the campaign (i.e. up to the end of 1941). Therefore, in the Barbarossa simulation Replacements (R) are issued to a combat unit according to the original TOE used in its formation.

²² C. Bergstrom, A. Mikhailov, *Black Cross Red Star: Air War Over the Eastern Front Volume I*, Pacifica Military History, Pacifica, California, 2000, Appendix II, p. 261.

The resources lost as a result of battle are dependent on the particular land-air combat model used, which in turn employs a whole range of sub-factors. These include factors for Relative Overall Combat Proficiency (ROCP), Supply Distribution Efficiency (SDE), weapon technology, fatigue effects, fortification and terrain effects, and weather conditions.

i. Key Terms and Concepts used in the Combat Process

At this point it is necessary digress and although we will not go into excessive details here, it is very important to distinguish between 'Combat Losses' and 'Operational Attrition Losses'. Refer Volume VI – 'Relative Overall Combat Proficiency (ROCP): the ROCP of Soviet and Axis Forces in 1941' for detail on the concepts and terms used in this section. The key terms used in the 'Combat Process' are indicated (below) using 'single quotes' and capitals.

'**Combat Losses**' include losses as a result of the 'Combat Process' and include:

- '**Tactical Losses**', which are defined as all losses sustained as a direct result of enemy fire, enemy ordnance, 'Close Combat' or 'Tactical Surrender'.
- '**Operational Losses**', which are defined as all losses sustained as a direct result of 'Operational Surrender' and 'Operational Combat'. Note, land combat units that become isolated from any form of supply, as a direct result of combat, will experience progressively higher levels of 'Operational Combat' losses. These type of losses are not classified as 'Operational Attrition Losses' (see below), because they occur as direct result of enemy action, albeit delayed.

The reader should note that losses resulting from the combat process do not include '**Operational Attrition Losses**': these are covered by the separate 'Attrition Process' discussed in the next section.

In addition, all types of resource losses are characterised as 'Irrecoverable' (permanent), or 'Recoverable'. In this context, irrecoverably lost means lost for the duration of the campaign to the military resources of that side, and not necessarily permanently lost to any post-war society.

'**Irrecoverable Losses**' include:

- Personnel that were killed, missing (killed or captured), permanently unfit and 1/3 of all wounded (those assumed to be badly wounded).
- Equipment that was totally destroyed, abandoned or surrendered.

'Irrecoverable Losses' are shown as resources exiting the FILARM model along a dotted line in diagram FILARM. This is symbolised by the dotted line crossing the enclosed thick-line boundary (i.e. the model's boundary).

'**Recoverable losses**' include:

- Personnel that were 'Lightly Wounded' and 'Wounded'.
- Equipment that was 'Lightly Damaged' and 'Badly Damaged'.

'Recoverable Losses' remain within the integrated resource model. This is symbolised by the resource allocation lines exiting the 'Combat Process' and 'Attrition Process', and returning resources to the 'Campaign Reserves' state. After recovery, repair, etc, these resources may quickly be returned to combat units as 'Replacements (R)' or by entering entirely new combat units (MD and MND combat units).

ii. Outcomes of the Combat Process

The results of the 'Combat Process' are slightly different for land and air combat units.

Land Combat Units

For land combat units the outcome of the 'Combat Process' will vary as follows:

1. The land combat unit sustains resource losses, and will receive replacements if they are available and depending on priority. This is the usual outcome, with most losses occurring in the combat elements (fighting elements) of the combat unit.

In this case 'Irrecoverable Losses' leave the FILARM model.

'Recoverable Losses' are retained by the unit or are reallocated (and physically sent back) to a rear area. 'Campaign Reserves' represent all rear areas.

Extract from Volume 1 Part 1.3

'Lightly Wounded' personnel and 'Lightly Damaged' equipment (repaired by the combat unit) are not transferred back to the FILARM model's 'Campaign Reserves'. These types of 'Recoverable Losses' are manifested as a loss of readiness in the combat unit.

'Wounded' personnel and 'Badly Damaged' equipment is sent to 'Campaign Reserves'. This represents equipment such as tanks being sent to the rear area, or even the factory, for major repair; and wounded going to rear area hospitals. This is shown in diagram FILARM by some resources returning directly to the 'Campaign Reserves' after the 'Combat Process'. Ex-wounded and repaired equipment may be returned to the front after a suitable time delay. These resources are not necessarily returned to their original unit, because that unit may have ceased to exist or already have received other replacements to cover its losses. In this case, ex-wounded and repaired equipment becomes part of the overall available resources (i.e. part of the overall 'Campaign Reserves').

2. The land combat unit is 'Totally Destroyed' and for all practical purposes is wiped out. A combat unit is usually 'Totally Destroyed' as a result of an encirclement battle (but not always), sustaining tactical as well as massive operational losses.²³ Losses are experienced in the combat and support elements of the unit: losses will be catastrophic in the fighting elements of the unit (such as its tanks and infantry), as well as supporting infrastructures (such as personnel and trucks in its supply and fuel columns).

In this case most of the unit's resources are irrecoverably lost and exit the FILARM model. The unit is removed from the Order of Battle (OOB). The usually small number of recoverable losses is returned to the 'Campaign Reserves' immediately. This represents personnel who may escape from a 'pocket' due to breakout or infiltration through enemy lines. It should be noted that surviving resources in this situation are nearly always personnel with very little equipment, as this is usually abandoned in the retreat or pocket. A good combat model will ensure most heavy equipment such as tanks and artillery is lost in these situations.

3. The third outcome of the 'Combat Process' is that the land combat unit disintegrates as a cohesive fighting force, usually as a result of heavy losses or being overrun by enemy forces. In military terms this is called 'Shattering', and losses are again usually very heavy in the combat and support elements of the unit.

Generally, 'Shattering' is difficult to model in military simulations because its results can be extreme. For example, in 1941 several Soviet rifle and tank divisions shattered early in the campaign as they were overrun by German armoured and infantry units. These divisions were still in relatively good supply and had not been cut off from their rear areas. Despite this, these units irrecoverably lost almost all their heavy equipment and most of their personnel. In this case (in the FILARM model) the unit is classified as 'Totally Destroyed'. The reader should note here that 'Being in Supply' is an important condition in determining the likelihood of a unit 'Shattering'.

During Operation Barbarossa some Soviet combat units shattered but later managed to reorganise and reappear in the Order of Battle (OOB), albeit usually at a considerably reduced strength. However this occurrence was almost always accompanied by large numbers of replacements which were available to effectively rebuild the unit. Shattered combat units were often so badly damaged that it proved more economical to disband the unit, and use the available resources as general replacements and as cadre for new combat units. In some cases this was also probably better for morale: who wants to be assigned to a combat unit that was all but destroyed or with a poor overall record?

A good land-air combat model simulates the conditions under which a combat unit might shatter. Depending on the type of 'Shattering' and overall situation, a percentage of losses are then classified as 'Recoverable Losses'.²⁴ In the FILARM model, recoverable resources from shattered units are returned via the 'Disband and Shatter Process' to the 'Campaign Reserves'. This simulates surviving resources from shattered units being withdrawn to the rear area for use as replacements or as cadre in newly mobilised combat units. The FILARM model, and land-air combat model, also simulate the fact that the surviving resources will contain a greater proportion of heavy equipment (such as tanks and artillery) than in the 'Totally Destroyed' conditions described previously.

²³ In WWII this was relatively uncommon on the Western Front, especially for divisional sized combat units, (examples were the surrender of Axis forces in North Africa, and in Germany in 1945). However, the almost complete destruction of whole divisions was not uncommon on the East Front from 1941 to 1945. Many Soviet corps, and even entire armies, were 'Totally Destroyed' during Operation Barbarossa in 1941.

²⁴ For example, the readiness and supply state of a combat unit that is overrun (and shatters) will be generally proportional to the amount of recoverable resources.

Air Combat Units

For air combat units the outcome of the 'Combat Process' will vary as follows:

1. The air combat unit sustains resource losses, and will receive replacements if they are available and depending on priority. This is the most common 'Combat Process' outcome and all other processes are identical to those for land combat units.
2. The air combat unit is 'Totally Destroyed' and wiped out. For air units this is relatively rare because most air units are already well to the rear and shouldn't be overrun quickly. They can fly their serviceable aircraft out of an encircled area and usually have time to get many unserviceable aircraft repaired, at least sufficiently to get them out. Also, most air units have aircraft with spare airlift capacity (especially bomber units) enabling at least a portion of their ground personnel to fly out of danger. However, air units forced to relocate solely by airlift will usually lose most of their heavy ground support equipment. This is usually simulated by the irrecoverable loss of these resources, and the air unit being unable to fly many combat missions for some time.

Total loss of an air unit can occur as a result of a series of successful air strikes on the air unit's airfields, accompanied by a rapid encirclement battle trapping the air unit's ground forces. These conditions were met in the early stages of Operation Barbarossa for many Soviet Military Air Force (*Voyenno-Vozdushnye Sily* or VVS) air combat units in the Western Military Districts. The result was that many Soviet aviation regiments disappeared from the VVS's Order of Battle (OOB) relatively quickly in 1941. In this case all other processes are identical to those for land combat units.

3. The air combat unit disintegrates as a cohesive fighting force. So called 'Shattering' of air units is rare because of the nature of air warfare. However it can occur if the air unit's airfields are quickly overrun, or exceptionally heavy and successful airfield air strikes are carried out against it. It is more likely that a unit suffering such heavy losses, in the air and on the ground, would be subsequently disbanded. In this case resources from shattered air units that are recoverable are returned via the 'Disband and Shatter Process' to the 'Campaign Reserves'. This represents surviving ground support resources and serviceable aircraft being withdrawn to the rear area for use as replacements or in forming new air units.

d. The Attrition Process

The 'Attrition Process' is concerned with losses in all combat units, regardless of deployment, due to 'Operational Attrition'. Such losses are referred to as 'Operational Attrition Losses' or simply 'attrition losses'.

'Operational Attrition Losses' are defined as all losses due to training accidents, other accidental loss and scrapping. In addition they are losses due to desertion, disease, sickness and frostbite, which are **unrelated to any 'Tactical Level Combat'**. Therefore **losses resulting from the 'Attrition Process' do not include any type of 'Combat Losses'** (refer above). Note, 'Operational Attrition Losses' are not the same as 'Operational Losses'. The latter occurs as a direct result of enemy action and are a form of 'Combat Losses', albeit often delayed.²⁵

Generally it is difficult to accurately simulate attrition losses in a military campaign. This is because attrition losses are largely dependent on the command decisions made during the campaign, similarly to 'Combat Losses'. However attrition losses are additionally influenced by longer term factors such as: the duration and quality of the pre-combat training programmes, the weather, the state of supply and support organisations, the age of equipment, and long term strategic planning.

i. Outcomes of the Attrition Process

The results of the 'Attrition Process' are slightly different for land and air combat units.

Land Combat Units

Until the winter of 1941-42, attrition losses in the land forces on the East Front (as opposed to the air forces) were fairly insignificant compared to combat losses, except in the area of motorised transport. Both Axis and Soviet trucks and light transports were predominately civilian types, which broke down frequently on the poor roads. Most of these trucks were repairable, provided the overall offensive or defensive situation allowed

²⁵ Refer to Volume VI – 'Relative Overall Combat Proficiency (ROCP): the ROCP of Soviet and Axis Forces in 1941' for further definition and explanation of these terms and concepts.

the support infrastructures time to do this.²⁶ Therefore the large majority of vehicle breakdowns ('Operational Attrition Losses') were not irrecoverable and only 'Irrecoverable Losses' actually exit the FILARM model.

For these reasons 'Operational Attrition Losses' in land combat units in the FILARM model are simulated in three ways:

1. The recoverable attrition losses are retained for repair within the land combat unit and these losses are simulated by a loss of combat readiness of the unit. The readiness recovery (or speed of repair) is affected by the operational proficiency for a side, the Supply Distribution Efficiency (SDE), and the overall state of supply to the combat unit at any given time. Thus unserviceable motor vehicles are still listed as on the unit's strength, but are not immediately usable.
2. If the particular land combat unit moves, a larger proportion of its equipment is lost due to attrition. The attrition losses are affected by: the distance moved, the frequency of movement, the mobility of the unit (e.g. highly motorised or mostly horse drawn), the terrain, the availability and condition of any roads, and the weather. A calculated proportion (usually small) of these lost resources become 'Irrecoverable Losses' and exit the FILARM model. Recoverable attrition losses due to movement are simulated by additional unit readiness loss (as above). The more demands that are made on a particular combat unit without a recovery period to consolidate, recover and reorganise, then the higher the attrition losses. The skill of any military commander is to judge how far to push a combat unit before it wears itself out: push to far and the combat unit becomes very vulnerable to enemy attack and risks 'Shattering' in combat. Needless to say, when the winter of 1941-42 arrived the proportion of attrition losses that became 'Irrecoverable Losses' rose dramatically.
3. The attrition losses in combat units in a MND state are built into the equipment allocated to these units from 'Campaign Reserves'. This is necessary because in the FILARM model MND units didn't see combat in 1941, and are not moved about the battlefield by that side's Barbarossa simulation 'commander' (player). However even though these units never went to an active front in 1941, they still experienced 'Operational Attrition Losses', albeit much lower than D and MD combat units.

Air Combat Units

During Operation Barbarossa, and many other campaigns in WWII, aircraft losses due to 'Operational Attrition' were not insignificant compared to 'Combat Losses'. 'Operational Attrition Losses' of aircraft were often severe; particularly training related and other flying accidents which resulted in 'Irrecoverable Losses'. It is a feature of air warfare that throwing large numbers of inexperienced pilots against even small numbers of excellent pilots is generally a very bad idea. It turns out that one of the principal reasons for this (but not the only reason) is that inadequately trained pilots, thrown prematurely into a combat environment, experience very high numbers of non-combat losses. Land and air warfare are quite different in this regard. This occurs even if the aircraft have similar technical capability, and is greatly exacerbated if the more inexperienced pilots also have inferior or obsolescent combat aircraft.

One of the key differences between land and air warfare is that rushed training programmes, often accompanied by hastily produced aircraft, dramatically raises the number of accidental losses without producing a significant increase in overall combat power. Essentially, if an aircraft breaks down in flight due to rushed quality control or maintenance, or is lost due to aircrew error, then it's usually a total write-off. Unfortunately the aircrew are also often lost and the aircraft support crews learn very little. By comparison, if a tank breaks down for the same reasons then it's usually repaired and is a better vehicle, along with a more experienced tank crew and tank support crew. It is relatively difficult for a tank crew to write off a tank by accident! To illustrate this point, between 22nd June and 31st December 1941 the Soviets lost over 26 000 aircraft.²⁷ Of these, approximately 10 600 were 'officially' non-combat losses.²⁸ Thus over 40% of the total VVS aircraft losses in

²⁶ The reader should note that for many Red Army units in the Western Military Districts in June-July 1941, breakdown of any tank, truck or similarly motorised equipment was usually fatal (eventually became an irrecoverable loss). This was because of the speed of the German encircling operations, which were moving eastwards faster than many Red Army units could retreat (even if they had been immediately ordered to do so). This left no time for Red Army unit to repair many of these vehicles before they were overrun or encircled.

²⁷ C. Bergstrom, A. Mikhailov, *Black Cross Red Star: Air War Over the Eastern Front Volume I*, Pacifica Military History, Pacifica, California, 2000, p. 252. 21 200 aircraft lost in official figures plus 5 240 "unaccounted for decrease in VVS strength" between 22nd June and 31st July 1941. Also refer to Volume IIIB, chapter and section titled – 'The Soviet Air Forces in 1941- Overall Soviet Combat Aircraft Usage, Production and Replacements (R): 22nd June to 31st December 1941- Review of the VVS Aircraft Losses in 1941', for further analysis of these figures.

²⁸ G.F. Krivosheev, et al. *Soviet Casualties and Combat Losses in the Twentieth Century*, ed. Colonel General G.F. Krivosheev, Greenhill Books, London, 1997, p. 254, table 95.

1941 were, apparently, non-combat losses! Of particular note is that of the apparent 10 600 non-combat losses, 7 600 were front line combat aircraft and not (more expendable) training aircraft.²⁹

Accurately simulating the VVS's 'Operational Attrition Losses' in 1941 is tricky because the Soviets could have reduced their losses by making different operational and strategic command decisions. By reducing the number of inexperienced air combat units thrown into the front line, and hence increasing the training time, the VVS would have almost certainly reduced its 'Operational Attrition Losses'. This operational-strategic level command decision would not have increased the factory quality control and testing of new aircraft, but it would have given air units more time to iron out problems with new aircraft in the field before committing them to combat.

The two practical ways available to simulate aircraft 'Operational Attrition Losses' are to only issue combat aircraft that 'survive training' to front line air combat units, or build 'Operational Attrition' into the operational proficiency and readiness of all air combat units. I believe the latter is the superior model because it enables different operational decisions to influence the air-land campaign, as opposed to the Soviets simply 'losing' 7 600 combat aircraft even if they never fly a single combat mission. By adopting the second model the VVS air units also have the ability to increase their operational proficiency over time, provided the Soviet simulation 'commander' gives them time to do this (which the Stavka and VVS High Command generally didn't do in 1941).

For these reasons 'Operational Attrition Losses' in air combat units in the FILARM model are simulated in three ways:

1. The recoverable attrition losses are retained for repair within the air combat unit, and these losses are simulated by a loss of combat readiness of the unit. The readiness recovery (speed of repair) is affected by the operational proficiency for a side, the Supply Distribution Efficiency (SDE), and the overall state of supply to the combat unit at any given point in time. Thus unserviceable aircraft are still listed as on the unit's strength, but are not immediately usable.
2. The irrecoverable attrition losses are simulated by the unavailability of the air combat unit to carry out combat missions. This is controlled by the operational proficiency values for a side, and represents time spent in training and loss of combat capability as a direct result of irrecoverable attrition losses. Thus a low proficiency air unit may become unavailable for operations even in a rear area were it wasn't involved in direct combat. The lower the operational proficiency, the more likely the unit will become unavailable for combat, even after relatively few combat missions. The opposite effect occurs for high proficiency, highly trained units.
3. The attrition losses in air combat units in a MND state are built into the equipment allocated to these units from 'Campaign Reserves'.

e. The Disband and Shatter process

The 'Disband and Shatter Process' is grouped together because 'Shattering' and disbandment of combat units is similar. The difference between the two is essentially the proportion of recoverable resources that occur. In the shatter case, the number of recoverable resources varies widely, while in the disband case the vast majority of resources are usually recoverable.

i. Combat Unit Shattering

A shattered unit only arises as a direct result (outcome) of the 'Combat Process'.

In this case the unit is shattered regardless of any higher command decisions, and the severity of shattering is calculated by the combat model and combat conditions at the time.³⁰ In the worst cases of combat unit shattering relatively few resources will be recovered, but in the best cases the majority will survive to be reused. The combat unit's readiness, supply state and Relative Overall Combat Proficiency (ROCP) when it shatters, are factors used in determining the proportion of the unit's resources that become 'Recoverable

²⁹ Ibid. There is strong evidence that Krivosheev's figure for non-combat losses is much too high. It seems very improbable that 72% of non-combat losses were front-line aircraft and only 28% were trainers or transports. Considering that Krivosheev's figures also ignore the 5 240 "unaccounted for decrease in VVS strength" between 22nd June and 31st July 31st, and the discrepancy between Krivosheev figure for total combat losses (10 600 in 1941) and Luftwaffe claims (around 20 400 by the end of 1941), it seems very likely a much larger proportion of "non-combat losses" were actually combat losses. Also refer note 97 (above).

³⁰ Refer to the 'Combat Process' above. Also Volume VI for the requirements of the combat model in a Barbarossa simulation.

Losses'. All 'Recoverable Losses' from shattered units are reallocated to the 'Campaign Reserves', while all 'Irrecoverable Losses' exit the FILARM model from the 'Combat Process'.

A shattered unit's 'Recoverable Losses' are represented in diagram FILARM by recoverable resources entering the 'Disband and Shatter Process' from the 'Combat Process', and then being reallocated to 'Campaign Reserves'.

ii. Combat Unit Disbandment

Disbandment of combat units only occurs as a result of a higher command decisions, and thus the 'Disband Process' is more complex and applies in several situations.

Combat units that go through the 'Disband Process' are categorised as follows:

1. The combat unit is in such poor condition as a result of combat that a command decision is made to disband it, and use the surviving resources as replacements and for newly mobilising units.

This is represented in diagram FILARM by resources being reallocated from a D or MD combat unit, via the 'Attrition Process' and the 'Disband and Shatter Process', and into 'Campaign Reserves'. Note, the resources in this case are not reallocated via the 'Combat Process' because the unit survived the combat as a cohesive force and was disbanded by a command decision. The combat unit could have been withdrawn to a rear area to rebuild by a different command decision: in which case it would have remained a D or MD unit in the rear area and received 'Replacements (R)'.

2. The combat unit was historically never committed to combat with its original TOE, no longer conformed to current requirements, and a command decision was made to wholly or partially disband the unit and utilise its resources.

In this case of unit disbandment, the unit may initially be in a D, MD, or MND state and may not conform to current requirements for any number of reasons. These may include: being organised using a TOE structure that is no longer supported or usable, the unit may not be able to get sufficient recruits from its local recruitment area to achieve an adequate strength, or the unit is serving no useful purpose in a secondary theatre and it is easier to disband it rather than move the entire unit. It is considered that some attrition of resources would occur in all these cases. This is represented in diagram FILARM by resources being reallocated from a D, MD or MND combat unit, via the 'Attrition Process' and the 'Disband and Shatter Process', into 'Campaign Reserves'.

A historical example is the Soviet 6th Tank Division (classified as a Deployed (D) unit) in the Transcaucasus Military District on 22nd June 1941. It was disbanded in September 1941, having never seen combat and never having left its formation area, even though it had 348 tanks and tankettes on strength.³¹ Most of the resulting resources were reallocated as replacements for other tank units, while some went into the new 6th Tank Brigade (a new Mobilised and Deployed (MD) unit). Thus all the 6th Tank Division's resources were reallocated via the 'Attrition Process' and the 'Disband and Shatter Process', and into the 'Campaign Reserves'.

In some cases only a portion of the combat unit was disbanded. For example, the Soviet 58th Tank Division was partially disbanded in late July 1941 in the Far Eastern Front when it was reorganised from the pre-war TOE (*Shtat*) to the smaller July 1941 TOE. In this case approximately 180 tanks and tankettes were released for other combat units.³²

3. The combat unit was historically committed to combat. Subsequently, the unit was disbanded with the specific plan of reallocating all of its resources and part of its initial TOE structure to form a (so called) new combat unit.

In this case the combat unit is officially disbanded by renaming it as a 'new' unit, and usually (but not always) adding additional resources from reserves. The disbanding unit may initially be an existing unit from 22nd June 1941 (i.e. a Deployed (D) unit), or it may be a newly mobilised unit. Note, however, that after undergoing the 'Disband and Shatter Process' a unit can only ever be reclassified as a MD or MND unit: i.e. once an existing Deployed (D) unit is disbanded, any new unit created from its resources is

³¹ Refer Volume III, chapter and section titled – 'The Actual Strength of all Soviet Land Combat Units in a Deployed (D) State on 22nd June 1941: The Soviet Tank Deployment Matrix'. Also, C. C. Sharp, 'The Deadly Beginning': Soviet Tank, Mechanised, Motorised Divisions and Tank Brigades of 1940-1942, Soviet Order of Battle WWII: Volume I, George F. Nafziger, West Chester, OH, 1995, pp. 21 and 71.

³² Ibid, Volume III. The 58th Tank Division was subsequently committed to combat in the West in October 1941, but not with its original TOE from 22nd June 1941. Also, C. C. Sharp, 'The Deadly Beginning': Soviet Tank, Mechanised, Motorised Divisions and Tank Brigades of 1940-1942, Soviet Order of Battle WWII: Volume I, George F. Nafziger, West Chester, OH, 1995, p. 45.

considered a newly mobilised unit. It is considered that some small attrition of resources would occur in all these cases.

This procedure is almost entirely (and extensively) utilised by the Soviet FILARM model, where it is discussed in detail.³³ This is because the massive Soviet mobilisation programme in 1941 called for a large number of existing divisions to be renamed and reformed as ‘new’ divisions. The complete sequence of processes and resource reallocation is represented in diagram FILARM as follows. Resources are reallocated from units in a D, MD or MND state, via the ‘Attrition Process’ and the ‘Disband and Shatter Process’ to the ‘Campaign Reserves’ state. Then the resources are reallocated, via the ‘Check the TOE Authorisation of a MD or MND Unit Process’, to the newly mobilised (renamed in reality) combat unit.

For example, consider the case of the Soviet 131st Mechanised Division in the Kiev Special Military District on 22nd June 1941. After a short period in combat, it was redesignated the 131st Rifle Division on 3rd July 1941. The only truly new component in the ‘new’ 131st Rifle Division was the 743rd Rifle Regiment, which was added from reserves.³⁴ Soviet mechanised divisions normally had two motorised regiments, a tank regiment and an artillery regiment. New rifle divisions in July 1941 had three infantry regiments and an artillery regiment. Thus by replacing the tank regiment with a rifle regiment, and a reduction in motorisation, a ‘new’ rifle division was formed. As the 131st Mechanised Division’s tank regiment had virtually ceased to exist by July 1941 (due to combat losses), and the division started the war with only 595 trucks and 69 tractors, this conversion was pretty easy to do and was largely a paper exercise.³⁵

In this example the 131st Mechanised Division starts as a Deployed (D) unit which experienced considerable ‘Irrecoverable Losses’ via the ‘Combat Process’. However the unit did not shatter in combat, was never ‘Totally Destroyed’, and remained a relatively strong and cohesive combat unit. On 3rd July a command decision caused the unit to be effectively disbanded with the plan to utilise all its resources to form the so called new 131st Rifle Division. Thus all the 131st Mechanised Division’s resources were reallocated via the ‘Attrition Process’, the ‘Disband and Shatter Process’, the ‘Campaign Reserves’, the ‘Check the TOE Authorisation of a MD or MND Unit Process’, and into the ‘new’ 131st Rifle Division. Note that these resources were reallocated only, and not necessarily physically moved, in order to become part of the ‘new’ division. Simultaneously the new 743rd Rifle Regiment, formed from ‘Mobilised Personnel’ entering the FILARM model and going into ‘Campaign Reserves’, was allocated to the ‘new’ division. Therefore, apart from some Replacements (R), the only genuinely new resources that were used in forming the ‘new’ 131st Rifle Division were those in a single new rifle regiment.

In many Operation Barbarossa simulations (and accounts of the campaign) the 131st Rifle Division appears as a completely new rifle division at virtually full strength. Even worse, the 131st Mechanised Division continues in the line! This very significant error is often repeated for many ‘new’ Red Army divisions mobilised from June to December 1941.

One of the great benefits of the FILARM model is that it enables military simulation designers to avoid unrealistic and ahistorical results of the type described above. This is critical if the military simulation is striving to achieve historical accuracy, and produce a realistic analysis of probable alternative historical outcomes. The three disbandment scenarios described above, and the overall structure of the FILARM model, are all geared towards this objective. Equally important for historical accuracy, is that the ‘Shatter and Disband Process’, and its implementation in the FILARM model, allows the simulation ‘commander’ (player) to have the same operational freedom of action as the historical protagonists.³⁶

³³ Refer to Volume IIIB, chapter titled ‘Soviet Mobilisation After 22nd June 1941: The Actual Strength of all Soviet Land Combat Units Mobilised from 22nd June to 31st December 1941’.

³⁴ C.C. Sharp, ‘Red Tide’: Soviet Rifle Divisions Formed From June to December 1941, Soviet Order of Battle WWII: Volume IX, G. F. Nafziger, West Chester, OH, 1996, p. 20.

³⁵ C.C. Sharp, ‘The Deadly Beginning’: Soviet Tank, Mechanised, Motorised Divisions and Tank Brigades 1940-1942, Soviet Order of Battle World War II Volume 1, G. F. Nafziger, West Chester, OH, 1995, p. 59.

³⁶ Refer to Volume I, Part I 2. 2) g) ‘The Integrated Land and Air Resource Model - The Objectives of the Integrated Land and Air Resource Model - Operational Freedom of Action (within the simulation)’, for additional perspectives on this topic. Also refer to Volume IIIB, chapter titled ‘Soviet Mobilisation After 22nd June 1941: The Actual Strength of all Soviet Land Combat Units Mobilised from 22nd June to 31st December 1941’.

Extract from Volume I Part I 3.